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THE UNIVERSITY OF ALBERTA

ON THE RELATION BETWEEN TIP-OF-THE-TONGUE STATES AND WORD FINDING PROBLEMS OF OLDER ADULTS

BY

ROBERT B. HELLER ©

A thesis submitted to the Faculty of Graduate Studies and Research in partial fulfillment of the requirements for the degree of DOCTOR OF PHILOSOPHY.

DEPARTMENT OF PSYCHOLOGY

EDMONTON, ALBERTA

SPRING 1992

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FACULTY OF GRADUATE STUDIES AND RESEARCH

The undersigned certify that they have read, and recommend to the Faculty of Graduate Studies and Research for acceptance, a thesis entitled ON THE RELATION BETWEEN TIP-OF-THE-TONGUE STATES AND WORD FINDING PROBLEMS OF OLDER ADULTS submitted by ROBERT B. HELLER in partial fulfillment of the requirements for the degree of DOCTOR OF PHILOSOPHY.

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December 16, 1991

DEDICATION

To my grandma who taught me the most about aging.

To my wife who taught me the most about patience.

ABSTRACT

The goals of the present research were to identify the underlying cause or causes of tip-of-the-tongue (TOT) states and to use this knowledge to understand further the nature of word finding problems associated with aging. According to one view, TOT states arise because of the inadvertent activation of a non-target that interferes with the activation of the target. According to an alternate view, TOT states are a result of incomplete activation of the target at the phonological level.

The first two experiments were conducted with samples of university students to test the predictions regarding the effect of non-target activation on the TOT probability. Contrary to both views, the presentation of a non-target after a definition had no effect on TOT probability regardless of whether the non-target was phonologically or semantically related to the target.

The next three experiments were conducted with samples of university students to determine whether some targets were more susceptible to TOT states than other targets as predicted by the two views. Surprisingly, low frequency targets were no more susceptible to a TOT state than high frequency targets. However, targets that were low in phonological distinctiveness tended to produce more TOT states than targets high in phonological distinctiveness. Similarly, targets that were low in lexical distinctiveness led to more TOT states than targets high in lexical distinctiveness. These findings suggested that as the number of 'competing' non-targets increases, the probability of a

TOT state increases.

The sixth experiment was carried out with a sample of young and older adults to determine whether the number of 'competing' non-targets affected TOT probability in older adults in the same way as it affects TOT probability in younger adults. Although the results of the final experiment revealed no age differences in TOT probability, the findings did show that older adults were not as sensitive to the number of competing neighbours associated with a target as were younger adults.

Two conclusions were drawn from the present set of experiments. First, the underlying cause of TOT states may be related to the number of competing neighbours at the phonological level and lexical level. Second, the word finding problems associated with older adults may be related to changes that affect the lexical distinctiveness of targets.

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A common complaint among older adults is a perceived increase in word finding difficulty (e.g. Sunderland, Watts, Baddely, & Harris, 1986). This observation is somewhat surprising given the lack of reported age differences in size of vocabulary knowledge (e.g. Botwinick & Storandt, 1974) and accuracy of lexical decisions (e.g. Cerella & Fozard, 1984). Older adults do however, tend to make more errors than younger adults when naming pictures (Albert, Heller, & Milberg, 1988; Borod, Goodglass, & Kaplan, 1980; Goodglass, 1980; Labarge, Edwards, & Knesevich, 1986; Nicholas, Obler, Albert, & Goodglass, 1985; Obler & Albert, 1985) and finding a word for a given definition (Bowles & Poon, 1985a). There also is evidence that age-related word finding problems exist in expressive language. Several researchers have reported that older adults use more indefinite terms and pronouns in discourse in a variety of situations (Heller, Dobbs, & Rule, submitted; Obler & Albert, 1985; Ulatowska, Cannito, Hayashi, & Fleming, 1985; Walker, Robert, & Hedrick, 1988).

The evidence for word retrieval difficulties in older adults is unequivocal, however, there has been little offered in the way of theoretical interpretation (but see Burke, MacKay, Worthley & Wade, 1991). Light (1988) has noted that the word finding deficits of older adults are hard to interpret within the current resource-based explanations of age differences in cognitive processes. One reasonable starting point would be to consider the various theoretical frameworks that have been used to interpret the classic word finding problem, namely, the well-known tip-of-the-tongue (TOT) phenomenon (Brown & McNeill, 1966). A TOT experience is characterized by a temporary inability to retrieve the complete phonological features of a word even though the person 'knows' the word being sought and would recognize the word if presented. Not too surprisingly, there is a growing body of evidence that suggests an age-related increase in TOT experiences (Burke et al., 1991; Cohen & Faulkner, 1986; Maylor, 1990a; although see Maylor, 1990b).

The goal of my dissertation was to examine the different theoretical interpretations of TOT states and apply this knowledge toward understanding the word finding problems associated with aging. Five experiments were carried out with samples of university students and were directed toward testing different predictions generated by two competing TOT interpretations. Based on the outcome of these experiments, a specific hypothesis for the word finding problems associated with aging was developed and tested in a sixth experiment by examining TOT experiences in groups of young and old adults. In the remainder of this introduction, a brief review of two competing TOT explanations is presented along with a summary of the evidence that is consistent and inconsistent with each view.

Theoretical Interpretations of TOT Experiences

Inadvertent Activation

According to one view, TOT states arise when a 'closely related non-target' becomes inadvertently activated and 'interferes' with the activation of the intended target (A. Brown, 1991; Jones, 1988). Furthermore, Reason and Lucas (1984) have suggested that once the unintended non-target is activated, there is a high probability that it will be repeatedly activated in subsequent word searches and function as a 'blocker' to impede or prevent the activation of the intended target (Reason & Lucas, 1984). Reason and Lucas (1984) assumed that words are represented as action schemas and have a level of activation determined by intentional factors (i.e. conscious search) and by non-intentional factors (i.e. context, recency/frequency, and associative relations). When the level of activation exceeds some threshold, the schema is activated and the word becomes available or 'propelled into consciousness'. When a related but unintended word is activated, a controlled word search is initiated often using features from unintended non-target. The erroneous search features along with the recent activation of the non-target (that temporarily lowers the threshold) makes the non-target even more available and increases the chance of repeated activation. The repeated activation of the non-target effectively 'blocks' the activation of the intended target and prolongs the TOT state.

In support of their interpretation, Reason and Lucas reported that almost 60% of TOT states, as recorded in cognitive diaries during a four week period, were associated with this type of non-target activation. Moreover, the non-targets that were repeatedly activated were rated as being more familiar and more associatively related to the context at the time of retrieval than were the actual targets. Thirty percent of the TOT states, however, occurred without any non-target being activated. Reason and Lucas suggested that these TOT states may be better characterized as 'hiccups' in the automatic retrieval processes, hiccups that were resolved before a non-target was activated. As for the remaining 10% of TOT states, a non-target was activated but not repeatedly. Reason and Lucas hypothesized that the non-targets associated with these TOT states provided erroneous features that misguided subsequent word searches. As a result, non-targets were less likely to be repeatedly activated.

According to the inadvertent activation hypothesis, the age-related increase in TOT states and other word finding problems is a result of an increase in the accidental activation of related non-targets. Although this interpretation is entirely reasonable, it is not consistent with the data that have been collected to date. If inadvertent activation underlies the age-related increase in TOT states, then there should be concomitant increase in the number of recurrently activated non-targets. This prediction, however, has not been confirmed by any of the studies on age and TOT states. According to the diary studies, older adults tend to have less target information available during a TOT state than do younger adults (Burke et al., 1991; Cohen & Faulkner, 1986). Moreover, older adults are less likely to produce a non-target while in a TOT state than are younger adults (Maylor, 1990a). These findings are hard to accommodate within the inadvertent activation view without making additional assumptions. It is unclear why there would be fewer non-targets activated if there are more slips of habits associated with aging.

Incomplete Activation

An alternate interpretation of the TOT state was first provided by Brown and McNeill (1966). They claimed that TOT states arise not because of inadvertent activation, but because of incomplete activation. According to Brown and McNeill (1966), words are stored in terms of dictionary entries with definitional information about the meaning of the word and featural information that specifies the spelling and sound properties of the word. Brown and McNeill further assumed that the spelling and sound features were not all equally 'legible' (i.e. accessible) within a word and that middle features often were less legible than outer features. They claimed that a TOT state occurs when a definition activates a word entry with illegible features, thus causing a temporary inaccessibility of phonological information. Because not all features were equally illegible, people are able to provide some information about the word they are trying to retrieve. Brown and McNeill further claimed that uncommon words were likely to have illegible features because of infrequent usage. Indeed, a fundamental assumption in all TOT research has been that TOT probability is inversely related to word frequency (see A. Brown, 1991), an assumption that has yet to be directly examined.

A recent reformulation of this view can be found in Burke et al.'s (1991) associative network model of language production called Node Structure theory. In Node Structure theory, three levels of processing units or nodes are arranged in a hierarchical fashion with symmetrical connections between nodes and across levels. The highest level of processing units is used to represent propositions and lexical items. The middle level of nodes is used to represent phonological information. The lowest level of processing units corresponds to the articulatory motor programs necessary for speech. There are two fundamentally different types of processes in Node Structure theory. The first process, priming, is a preparatory process that prepares nodes for the second process or activation. Activation processes are controlled by a separate class of nodes known as sequence nodes.

In this simplified description of Node Structure theory, a TOT experience is accounted for by postulating a deficit in the transmission of priming from the lexical nodes to the phonological nodes as a result of weakened connections. Because some of the phonological nodes have not been primed, activation cannot occur and thus some phonological information will remain inaccessible. Like Brown and McNeill, Burke et al. claim that frequency of use affects the strength of the connections to phonological nodes. Furthermore, Burke et al. claim that recency of activation and age also affect the strength of the connections between lexical and phonological nodes.

In support of their model, Burke et al. (1991) point out that speech errors and word substitutions are more likely to occur for low frequency words than for high frequency words, a finding that would be expected on the basis of the stronger connections associated with high frequency words. Burke et al. also assume that aging is associated with a general decline in the strength of the connections, an assumption that predicts an age-related increase in TOT states. Consistent with this prediction, Burke et al. reported an age-related increase in experimentally induced TOT states. Their model also predicts that reduced priming associated with aging will lead to less information being available during a TOT state, a finding that has been verified in diary studies (Burke, Worthley & Wade, 1987; Cohen & Faulkner, 1986). Finally, Burke et al. (1991) reported that the TOT states in older adults were associated with longer durations since the TOT target was last used, according to participants' self reports. This finding is consistent with the hypothesized relation between TOT probability and recency of activation.

There is, however, some evidence that is inconsistent with the Node Structure theory. Both Cohen and Faulkner (1986) and Reason and Lucas (1984) reported that TOT targets were rated as moderately familiar by their participants, a finding that would not be anticipated on the basis of the assumption regarding frequency and recency of use. Nevertheless, the model by Burke et al. (1991) appears better suited to accounting for age-related increase in word finding difficulties.

In order to further examine these two TOT interpretations, a set of predictions was generated from each interpretation regarding the effect of non-target activation on TOT probability and target type susceptibility to TOT states. Experiments 1 and 2 were designed to test the predictions regarding non-target activation and Experiments 3, 4, and 5 were designed to examine the predictions regarding target type.

Non-target Activation and TOT Probability

Jones (1988) pointed out that the two views regarding the underlying cause of TOT states lead to different predictions about the effect of a non-target becoming activated during word search. If inadvertent activation underlies TOT states, a related non-targets that becomes activated during the word search may interfere with activation intended for the target and 'propel' a person into TOT states. If incomplete activation underlies TOT states, however, non-targets that are related could increase the legibility/accessibility of phonological information and reduce the occurrence of TOT states.

In order to test between these two accounts, Jones and his colleagues (Jones, 1989; Jones & Langford, 1987) used a variation of the procedure introduced by Brown & McNeill (1966) to induce TOT states. In the original procedure, participants listened to a series of definitions and were asked to retrieve the word in question. Jones and his colleagues also presented non-targets or interlopers, as they called them, immediately after the definition. If non-target presentation is functionally equivalent to the unintentional activation of a 'blocker', then the likelihood of a TOT state should increase. If the provision of a related non-target facilitates the accessibility of certain features, then the probability of a TOT state should decrease.

Jones and his colleagues also examined whether semantic or phonological relatedness was more important in preventing or facilitating the occurrence of a TOT state. They used non-targets that were either semantically related, phonologically related, phonologically and semantically related, or phonologically and semantically unrelated to the target word. Reason and Lucas (1984) would likely argue that both types of non-targets, semantically related and phonologically related, could function as blockers because of the different non-intentional factors that lead to non-target activation. According to Brown and McNeill (1966), however, TOT states arise because of an inaccessibility to phonological information. Thus, phonologically related non-targets should be more helpful in facilitating the resolution of a TOT state than would semantically related non-targets. Burke et al. (1991) also claim that phonologically related non-targets would facilitate TOT resolution but only if the non-target came from a different syntactic category. According to their model, non-targets from the same syntactic category would delay TOT resolution. Unfortunately, Jones and his colleagues did not manipulate the syntactic category of the non-target nor did they measure the effect of non-target relatedness on TOT resolution. Thus, the predictions by Burke et al. (1991) cannot be addressed.

The results of studies by Jones and his colleagues show quite clearly that more TOT states occurred when phonologically related non-targets were presented after the definition (Jones, 1989; Jones & Langford, 1987). Accordingly, Jones argues that these results support the inadvertent activation hypothesis and are inconsistent with the incomplete activation view as put forth by Brown and McNeill (1966). These studies, however, have several problems that seriously limit the conclusions that were drawn.

First of all, the reported inhibitory effect of non-targets on TOT states appears to be an artifact of the materials. Perfect and Hanley (submitted) pointed out that Jones and his colleagues used only one type of non-target for each item and confounded item difficulty with non-target type. When Perfect and Hanley used the identical materials, they found the same pattern of TOT states occurred *regardless* of whether a non-target was presented. Maylor (1990a) used the same materials on older adults and generally replicated Jones's findings. She found however, that the words normally presented with phonologically related non-targets were considerably easier to retrieve in a condition where non-targets were not presented. Finally, Askari (1991) used a procedure that was similar to Jones's but counterbalanced the type of non-target for each target across participants. In contrast to Jones and Langford (1987), Jones (1989) and Maylor (1990b), Askari (1991) found phonological non-targets did not affect the frequency of TOT states, but rather, facilitated the correct retrieval of targets. However, Askari (1991) presented non-targets in separate blocks so participants may have been using different types of search strategies for different non-targets. It remains to be seen whether the same effects would occur if the different non-targets were randomly presented.

A second problem with the studies by Jones is that the only control condition was the presentation of a phonologically and semantically unrelated non-target. It may be that the mere presentation of a non-target, related or unrelated, has indirect effects on the word retrieval processes. Jones (1989) suggested modification of his procedure that partially addresses this issue. In this modified procedure, non-targets would be provided only if a TOT state occurred. Thus, the effect of a non-target on the resolution of a TOT could be directly compared to cases where no non-targets are presented following a TOT. Although this modification would yield valuable information, it would entail a considerable amount of 'TOT prospecting' in order to make reliable comparisons. In an alternative procedure, Askari (1991) included a control condition in which a non-target is not presented in order to determine a baseline level of performance for each target. The baseline was then used to assess the effect of different non-targets on the word retrieval. As mentioned earlier, although Askari (1991) reported no effect of non-target on TOT probability, non-targets were presented in blocks which may have led participants to respond strategically to the non-targets.

Finally, there are several reasons for being cautious when comparing the effects of a phonologically related non-target to a semantically related non-target in the same experiment. First, it is unclear whether the information associated with the non-target was being processed as intended by the experimenter. The definitions in Jones's studies were followed by one of the four types of non-targets in a random order. The participants were told that the non-target may be related but they were not told how it would be related. Thus, it is never clear on any trial whether the participant is processing the semantic information associated with the non-target or the phonological information or both. More importantly, it is not even clear whether the participant is even processing the information from the non-target since there were no manipulation checks to ensure the non-target was still available during target retrieval. A better procedure would be to test each non-target under conditions in which subjects were aware of the nature of the possible relationship between target and non-target and to ensure that the non-target was available during retrieval.

A second reason for being cautious is that there are differences in the ease with which the participant can determine whether a non-target is semantically or phonologically related to the target. Subjects can always determine whether the non-target is semantically related to the target on the basis of the definition (provided that they are familiar with the non-target). However, subjects can never determine if the non-target is phonologically related to the target on the basis of the definition. The difference in determining whether a non-target is semantically or phonologically related may lead subjects to use the non-target in a systematic fashion. For instance, if a semantic relationship is detected, the non-target can be discarded as a possible candidate and the word search can be narrowly focused. If no semantic relationship is detected, at least two possibilities may occur. The non-target may be discarded and target retrieval could continue on the basis of the definition only. However, another possibility is that the phonological information associated with the non-target may be used to help retrieve the target because when there is no semantic relationship between non-target and definition, the likelihood of the non-target and target being phonologically related is 50%. This imbalance may lead subjects to rely more on the phonological properties of a non-target when it can be determined as being semantically unrelated or if it is an unfamiliar word. Again, a better procedure would be to test each type of non-target separately so that biases in the use of semantic and phonological information would not be confounded.

A related reason for being cautious when looking at the effects of different non-targets is that semantic information associated with a non-target may not be as available on any given trial as is phonological information. The phonological information associated with a given non-target can always be accessed regardless of whether the word is known or not. However, the extent of semantic information that can be accessed depends on the familiarity of the non-target. Since half of the non-targets used by Jones were low frequency words, it is possible that a significant proportion of words were unfamiliar to subjects. The effect of semantically related non-targets on TOT states may therefore, be seriously underestimated in this procedure. Consequently, it may be unfair to compare the effects of the semantic non-targets to the effects of the phonological non-targets under these conditions.

The final and perhaps most important reason for being cautious is that strength of the semantic association between the non-target and the target is unknown. Typically, targets are unusual and infrequent words and lack important normative data regarding associative strength with other items. On the other hand, the strength of the phonological relation between target and interloper is likely quite high and quite consistent across items. It would be useful to have information regarding the strength of the semantic association in order to ensure that relatively strong associates are being tested. Moreover, information regarding the associative strength could be used to test predictions regarding the extent of hypothesized facilitory/inhibitory effect of interlopers. For example, according to Reason and Lucas (1984), stronger associates should lead to greater inhibitory effects than would weaker associates. In the present research, a normative study was conducted first to obtain this information.

In light of the problems outlined above, the effect of different non-targets on TOT probability was examined in separate experiments. Semantically related non-targets were examined in Experiment 1 and phonologically related non-targets were examined in Experiment 2. The basic procedure developed by Jones and his colleagues was used in both experiments with the following modifications. First, both experiments included a control condition in which a non-target was not presented. This condition enabled an assessment of the direction and magnitude of possible non-target effects on the occurrence of TOT states. Second, each target was tested with three possible non-targets in a between-subject design in order to control for item difficulty. Third, a manipulation check was included to ensure that the semantic and phonological properties of the non-targets were being processed. This was accomplished by including catch trials in which participants were asked to recall the non-target presented after the definition on randomly selected trials. Fourth, participants were asked to indicate whether the target word was familiar on each trial. Trials involving familiar targets were considered to be valid trials because the target was potentially retrievable. Trials involving unfamiliar targets were excluded from analysis.

Finally, Jones and Langford (1987) and Jones (1989) failed to include information about the number of successful and unsuccessful retrievals. Perfect and Hanley (submitted) have pointed out that a reported increase in TOT states does not necessarily imply that non-targets inhibit the retrieval of the target word. The increase in TOT states may have occurred because non-targets facilitate the partial retrieval of targets that normally would not have been retrieved. Alan Brown (1991) also raises concerns about the lack of information on successful and unsuccessful retrievals in previous studies. Consequently, in the present experiments, the effect of non-target types was reported and analyzed for all three response types; TOT states, KNOW IT states, and DON'T KNOW IT states.

An important consideration for Experiment 1 was the basis of selection for semantically related non-targets. Other researchers have relied upon common sense and/or thesauruses for selecting semantically related non-targets (Askari, 1991; Jones, 1989; Jones and Langford, 1987). In the present research, a more objective basis for selecting semantically related non-targets was achieved by carrying out a normative study prior to the first experiment.

The guiding assumption in the normative study was that the most frequently mentioned synonym for a target would be the best choice as a semantically related non-target. That is, a synonym of the target presented immediately after the definition should maximally inhibit retrieval if TOT states are caused by inadvertent activation. This assumption is shared by Askari (1991) who used a thesaurus to select synonyms as non-targets that were semantically related. However, a thesaurus does not adequately reflect the strength of the relation between a synonym and a target. In order to obtain this information, participants in the normative study were asked to generate as many synonyms as they could for a list of 64 items.

Normative Study

Method

Subjects. One hundred and seventy-seven students from an introductory psychology course participated in the first session of this normative study. The first session took place during a regular class meeting time and the students received credit toward their introductory psychology research participation option.

Sixty-three students from the first session volunteered to participate in a second session. The second session was carried out in order to collect normative information on the materials used in Experiments 5 and 6. The second session also took place during their regular class meeting time.

Materials. In the first session, 53 words were selected from Kucera and Francis (1967) and presented to the participants. In the second session, 11 additional words were selected from Kucera and Francis (1967) and presented to the participants. All 64 words were relatively concrete nouns, and no word had a frequency of occurrence greater than two occurrences per one million.

Procedure. Each word was presented on an overhead projector one at a time and the participants were asked to write the word down on a piece of paper and to indicate whether the word was familiar to them. Familiarity was explicitly defined as knowing what the word meant. Participants were then given approximately 45 seconds to write down as many synonyms as they could think of for each word. An example of synonyms for the word 'hotel' was given prior to the task and it was stressed that some items may not have any synonyms. Participants also were asked to indicate whether English was their first language.

Results

Of the 177 participants who participated in the first session, the data from 41 participants were not included because their first language was not English. The data from an additional 12 participants were excluded because these participants did not appear to have followed the instructions. The data from the remaining 124 participants were used as the normative data base for 53 of the 64 words.

Of the 63 participants who participated in the second session (a subset of the 177 participants from the first session), the data from 4 participants were not included because their first language was not English. The data from the remaining 59 participants were used as the normative data base for 11 of the 64 words.

For each item, the frequency of each synonym was expressed as the percentage of the participants who were familiar with the target. The 64 targets and the three most frequently mentioned synonyms are presented in Appendix 1. These findings were used as a basis for the selection of materials in Experiment 1.

Experiment 1

In Experiment 1, the goal was to assess the effect of semantically related non-targets on the occurrence of TOT states. According to the inadvertent activation hypothesis, semantically related non-targets should increase the probability of a TOT state. The normative study provided a reasonable basis for the selection of synonyms to use as semantically related non-targets. The occurrence of TOT states was compared across three conditions; when the definition was immediately followed by a semantically related non-target, a semantically unrelated non-target, or no non-target. The inclusion of a no non-target condition enables a determination of the effect of non-target presentation independent of non-target relatedness.

Method

Subjects. Seventy-one introductory psychology students participated in this experiment and received credit toward their research participation option. None of the students had participated in any previous studies involving TOT experience.

Materials. Twenty eight targets were selected from the normative study to use as experimental items and four targets were selected to use in catch trials. (See Appendix 2.) None of the targets began with a vowel (e.g. aviary), consonant cluster (e.g. crater), or an irregular orthographic pattern (e.g. gnome). All targets were relatively concrete nouns and no target had a frequency of occurrence that was greater than 2 occurrences per million according to Kucera and Francis (1967). The definitions for these targets were derived from the Concise Oxford Dictionary of English (7th Edition).

For the majority of the experimental targets, the semantically related non-target was the most frequently provided synonym from the normative study. When the most frequently provided synonym was phonologically related to the target, (e.g. cave was the most frequently generated synonym for cavern) the next most frequently given synonym was used as the semantically related non-target, and the most frequently provided synonym was incorporated into the definition. For some targets, the second or third most frequently provided synonym was used as a non-target because the most frequently provided synonym was a necessary part of the definition. The frequency of occurrence for the related non-targets ranged from 1 to 80 occurrences per million with an average frequency of 19.1 according to Kucera and Francis (1967).

The semantically unrelated non-targets were selected to match the related non-targets as close as possible in word frequency, number of syllables, and number of letters. Semantically unrelated non-targets only differed in meaning from related non-targets and neither non-target type began with the same initial letter as the corresponding target. All non-targets were relatively concrete nouns.

In addition to related and unrelated non-targets, four catch trial non-targets were selected for each catch trial target. None of the catch trial non-targets had a frequency of occurrence greater than 1 according to Kucera and Francis (1967) and all non-targets were phonologically and semantically unrelated to the catch trial target.

The experimental targets were then divided into two lists of fourteen. Each set was matched as closely as possible for the number of syllables in the targets, the frequency of occurrence for the non-targets, and the number of targets that began with the same letter. Within each list, the targets were randomly ordered with the constraint that targets beginning with the same letter and semantically related targets were separated by at least five targets. Two catch trial targets were randomly inserted into each list which brought the total number of targets in each list to sixteen.

A master tape was made for each list in the following manner. The target definition was read by a female graduate student and recorded on a Sony reel to reel tape recorder. The graduate student said 'Definition' prior to reading each definition aloud. After each definition was read, a short tone was recorded on the tape and followed by approximately 45 seconds of recorded silence. The remaining target definitions were recorded in an identical manner to create one master tape. The other list of 16 targets was recorded in the same manner to create the other master tape.

Each master tape was used to create three experimental tapes by recording each tape onto three cassette tapes. On each cassette tape, either a semantically related non-target or a semantically unrelated non-target was dubbed onto the cassette tape immediately after the tone following each definition, or the space following the tone was left blank. Three cassette tapes were made for each master tape in order to counterbalance the experimental targets with non-target type. The same group of targets that were followed by related non-targets on one cassette tape were followed by unrelated non-targets on the second cassette tape and no non-targets on the third cassette tape. For the catch trial targets however, the same catch trial non-target was recorded after the tone on all cassette tapes.

There were approximately the same number of non-target types on each cassette tape and the same non-target type never occurred on more than two trials in a row. The cassette tapes from the first master tape were paired with the cassette tapes from the second master tape having the same ordering of non-target types. Thus, across the three pairs of cassette tapes, the definition of each experimental target was presented three times and followed by the three non-targets types.

Procedure. Testing was done in a classroom setting with groups of ten or fewer participants. Each group was randomly assigned to one of the three pairs of cassettes tapes. At the conclusion of the experiment, 23 participants had been assigned to the first set of cassette tapes, 23 to the second set, and 21 to the third set. Within each set, the order of cassette tape presentation was counterbalanced across participants.

Participants were first told that the study was concerned with the TOT phenomenon and given an example of a common TOT experience (i.e. "knowing" the answer to a question from the game Trivial Pursuit and being unable to find the word). Participants were asked to listen to a tape recording of spoken definitions and to try and find the word being defined. They were told that each definition would be preceded by the word 'Definition' and end with a beep. After hearing the definition, participants indicated their initial response by circling one of three possible responses. If a word came to mind immediately after hearing the definition, participants circled the "KNOW IT" response, wrote their response in the space provided and then waited until the next trial.

If no word came to mind immediately after hearing the definition but they were certain that they knew the word and that it was on the tip of their tongue, participants circled "TOT" and also provided any information that they had about the word that they were trying to retrieve. The response booklet contain space for information regarding the beginning sounds, the middle sounds, the end sounds or the number of syllables. Participants also indicated whether any sound related words or meaning related words came to mind while they were in the TOT state and wrote these words in the spaces provided.

Finally, if no word came to mind immediately after hearing the definition and there was no feeling of knowing, participants circled the "DON'T KNOW IT" response. Participants also were asked to write down their best guess about the beginning sounds, the middle sounds, the end sounds and the number of syllables in the word. They also were asked to indicate whether any sound related words or meaning related words came to mind while they were in the DON'T KNOW IT state. This requirement was included to confirm the validity of TOT states.

If participants in TOT states were able to resolve their TOT state before the next definition was presented, they wrote down their word in the space provided. Similarly, participants in DON'T KNOW IT states were instructed to write down any word that came to mind before the next definition was presented.

After approximately 45 seconds of silence, the target word was revealed on an overhead and the word was spoken aloud. All participants were asked to indicate whether the word was familiar or not. In addition, participants who experienced a TOT and were unable to resolve it were asked to indicate whether the word on the overhead was the word that they were trying to retrieve. After 15 seconds, the next definition was presented. The same procedure was repeated for 31 more trials.

After instructing participants on the primary requirements of the task, they were then told that for some definitions, a word would be presented immediately after the beep that followed the definition and that the word would sometimes be related in meaning to the word being defined and sometimes it would be unrelated. They were told to remember this word because on some trials the examiner would ask them to recall the word immediately after the target word was revealed. At the end of the study, participants were fully debriefed and thanked for their participation.

Results

The frequency of the three basic response types was expressed as a percentage of the valid trials that occurred for each participant. Valid trials were defined as trials on which the target was rated as familiar (and hence potentially retrievable) and the participant's response was interpretable. The average number of valid trials per participant was 24.47 (out of 28 experimental targets).

KNOW IT Responses. KNOW IT responses occurred on 60.6% of the valid trials. KNOW IT responses were divided into two subtypes depending on whether the response was the same word specified by the definition or a different word; KNOW IT (Same) and KNOW IT (Different). Each KNOW IT response was analyzed separately in a one-way analysis of variance (ANOVA) with non-target type as a within-subject variable. For KNOW IT (Same) responses, there was a significant effect of non-target type, F (2, 140) = 3.175, $p < .05$. There were more KNOW IT (Same) responses when the non-targets were related than when they were unrelated but there were no differences in responses between blank non-targets and related non-targets or between blank non-targets and unrelated non-targets (related: M = 44.4%, unrelated: M = 37.6%, blank: M = 41.2%).

The effect of non-target type also was significant in the analysis of KNOW IT (Different) responses, F (2, 140) = 4.104, $p < .05$. This time, however, there were fewer KNOW IT (Different) responses when the non-targets were related than when they were unrelated or when they were blank. (related: M =15.4%, unrelated: M = 21.9%, blank: M = 21.4%).

TOT Responses. Tip-of-the-tongue responses occurred on 24.7 of the valid trials. Brown and McNeill (1966) referred to the analysis of TOT data as a "fragmentary data problem" because some words may fail to evoke a TOT state and some participants may never experience a TOT state. They suggested that the "best thing to do with fragmentary data is to report them very fully and analyze them in several different ways" (p. 328). This advice was followed in the present research by separating the TOT responses into four subtypes based on the distinctions introduced by Koriat and Lieblich (1974). In previous research, TOT responses appear to have been collapsed across subtypes for analyses (e.g. Askari, 1991), or 'negative TOT' states (i.e. an unresolved TOT state for a word unintended by the experimenter) were excluded from any analyses (e.g. Brown & McNeill, 1966). Koriat and Lieblich (1974) found subtle similarities and differences among the TOT subtypes, findings that warrant the inclusion of all subtypes in any study of the TOT phenomenon. Thus, TOT responses were separated into four subtypes depending on whether the TOT state was resolved before the next trial began (resolved or unresolved) and whether the word being sought was the target intended by the experimenter (same or different).

In order to get a better understanding of the four different TOT responses and how these responses are different from DON'T KNOW IT responses, Table 1 lists the amount and accuracy of different types of information that was provided in each of the TOT states and the DON'T KNOW IT state. For each response type, Table 1 lists the number of participants who reported having one or more of such a response and the percentage of trials in which information was correct or incorrect, or not provided at all. For the TOT (Same-Unresolved), TOT (Same-Resolved) and DON'T KNOW IT states, the accuracy of the information was assessed against the experimenter intended target. For TOT (Different-Resolved) states, the accuracy of the information was assessed against the target provided by the participant. Finally, for TOT (Different-Unresolved) states, the accuracy of the information was not assessed because the participant intended word was unknown. Table 1 also lists the percentage of participants who provided one or more meaning related words and sound related words for each response type.

Table 1

Accuracy of Information Provided by Participants in TOT States and DON'T KNOW IT States

	TOT Response Type				DON'T KNOW IT Response
	Same		Different		
	Unresolved	Resolved	Unresolved	Resolved	
	N = 58	N = 44	N = 53	N = 29	N = 66
BEGINNING SOUNDS					
% Correct	28.1	18.7		22.3	3.9
% Incorrect	9.5	7.0		3.4	14.1
% None Given	62.4	74.3	71.4	74.2	82.0
MIDDLE SOUNDS					
% Correct	6.3	2.7		6.3	0.3
% Incorrect	5.2	3.1		2.2	4.3
% None Given	88.5	94.2	93.0	91.5	95.4
END SOUNDS					
% Correct	11.2	7.8		19.5	0.2
% Incorrect	7.1	3.1		3.4	13.3
% None Given	81.7	89.1	84.4	77.0	86.5
NUMBER OF SYLLABLES					
% Correct	33.1	28.2		25.2	18.6
% Incorrect	16.6	10.0		5.1	19.7
% None Given	50.3	61.8	48.2	69.7	61.7
MEANING RELATED WORDS					
% Provided	34.5	24.0	36.3	32.3	25.0
SOUND RELATED WORDS					
% Provided	2.7	2.3	3.4	5.2	0.0

Because the composition of each subsample differs across the five response types, the use of statistical procedures to make comparisons across response types was limited. The overall pattern of means in Table 1, however, was replicated across all 6 experiments in the present research. Consequently, there are several general conclusions that can be reliably drawn from Table 1. First, the information provided by participants in DON'T KNOW IT states was incorrect considerably more often than correct whereas, the reverse was true for participants who were in TOT states. This observation suggests that the unsuccessful retrieval attempt that leads to a TOT state is genuinely different from the unsuccessful retrieval attempt that leads to a DON'T KNOW IT state.

Second, participants provided more information about the first letter of a word and the number of syllables than about middle letters or end letters, a finding consistent with previous research on TOT states (see A. Brown, 1991) and again verifies the validity of participants claims.

Third, participants in TOT (Same-Unresolved) states tended to provide more information (correct and incorrect) about the target than participants in TOT (Same-Resolved) states. On the basis of this observation, resolution per se may not depend on the amount of information that is provided but more on the 'quality' of the information that is initially retrieved. It also may reflect the fact that resolutions on average occurred before the end of the 45 seconds so there was less time available to provide information.

Fourth, the amount and accuracy of information provided by participants in TOT (Different-Resolved) is comparable to the information provided by participants in TOT (Same-Resolved) states. Similarly, although the accuracy of information provided by participants in TOT (Different-Unresolved) cannot be determined, the amount of information provided by these participants is comparable to the amount of information provided by participants in TOT (Same-Unresolved) states. Together, these findings warrant the analyses of TOT states involving targets unintended by the experimenter. Caution, however, must be used when interpreting any effect on these TOT states because the intended target generally varies across participants.

Finally, a considerable number of participants provided meaning related words for all TOT states and even for DON'T KNOW IT states. At the same time, participants were very unlikely to provide a sound related word. This finding suggests that the activation of meaning related words may be common occurrence during word search as opposed to the activation of sound related words. The paucity of sound related words is in contrast to the earlier research (e.g. Brown and McNeill, 1966; Koriat & Lieblich, 1974) which reported a large percentage of participants who provided sound related words while in a TOT state. This difference may be due to a demand characteristic in the instructions of earlier research as it was often explicitly stated that sound related words will come to mind while in a TOT state. This present finding also may reflect the greater ease of finding meaning related words (when the 'meaning' is well known because of the definition) over sound related words (when the sound is less known).

The findings from Table 1 provide a verification of the TOT responses as being different from the DON'T KNOW IT response and similar to the types of TOT responses that have been reported in previous research. The findings from Table 1 also provide justification for the inclusion of TOT (Different) subtypes in the subsequent analyses. These responses, however, were analyzed separately from TOT (Same) responses because non-targets were chosen with respect to a specific target. Thus, an effect of non-target type should be interpreted differently when the target is different from the intended target.

Performance on the catch trials was examined to insure that the non-targets were being processed. Participants were able to recall the non-target 93.3% of the time which indicated that non-targets were available during the time of target retrieval.

Table 2 displays the percentage of valid trials that each TOT response occurred on as a function of non-target type. The first two TOT response types shown in Table 2, TOT (Same-Unresolved) and TOT (Same-Resolved), were analyzed in a two-way ANOVA with non-target type (related, unrelated or blank) and resolution (resolved or unresolved) as within-subject variables. There was a significant effect of resolution, $\underline{F}$ (1, 70) = 17.764, $\underline{p} < .001$. There were more TOT (Same-Unresolved) responses ($\underline{M}$ = 8.9%) than TOT (Same-Resolved) responses ($\underline{M}$ = 4.7%). As shown in Table 2,

Table 2

Percentage of TOT Response Types (out of all Retrieval Attempts) as a Function of Non-target Type

	Non-target Type		
TOT Response Type	Related	Unrelated	Blank
Same-Unresolved	9.3	8.3	9.1
Same-Resolved	5.0	4.1	5.0
Different-Unresolved	10.1	8.1	6.6
Different-Resolved	2.8	3.5	3.0

Table 3

Percentage of TOT Response Types (out of Unsuccessful Retrieval Attempts) as a Function of Non-target Type

	Non-target Type		
TOT Response Type	Related	Unrelated	Blank
Same-Unresolved	23.1	27.9	24.5
Same-Resolved	14.0	8.0	13.5
Different-Unresolved	24.3	19.8	15.3
Different-Resolved	6.7	6.6	10.5

this effect occurred regardless of non-target type for each type of non-targets. There were no other significant effects.

The next two TOT response types, TOT (Different-Unresolved) and TOT (Different-Resolved) were analyzed in an identical ANOVA and again, there was a significant effect of resolution, $\underline{F}$ (1, 70) = 25.341, $\underline{p} < .001$. There were more TOT (Different-Unresolved) responses ($\underline{M}$ = 8.0%) than TOT (Different-Resolved) responses ($\underline{M}$ = 3.0%). Table 2 shows that this effect occurred regardless of non-target type. There were no other significant effects.

Another way to test the effect of non-target type on TOT probability is to examine the number of TOT states relative to unsuccessful retrieval attempts (as opposed to a percentage of all retrieval attempts). Alan Brown (1991) suggested that this measure could be useful as a means of controlling for differences in item difficulty. Table 3 displays the percentage of unsuccessful retrievals (i.e. excluding KNOW IT responses) that each TOT response type occurred on. Eleven participants were excluded because they only provided KNOW IT responses.

The first two TOT response types shown in Table 3 were analyzed in a two-way ANOVA with resolution and non-target type as within-subject variables. Consistent with the previous analysis, there was a significant effect of resolution, $\underline{F}$ (1, 59) = 25.363, $\underline{p} < .001$. There were more TOT (Same-Unresolved) responses ($\underline{M}$ = 24.0%) than TOT (Same-Resolved) responses ($\underline{M}$ = 11.3%) regardless of the non-target type as shown in Table 3.

There also was a significant effect of resolution in the analysis of the next two TOT responses, *F* (1, 59) = 19.292, *p* < .001. There were more TOT (Different-Unresolved) responses (*M* = 20.0%) than TOT (Different-Resolved) responses (*M* = 7.6%) regardless of non-target type as shown in Table 3.

DON'T KNOW IT Response. DON'T KNOW IT responses occurred on 14.7% of the valid trials. DON'T KNOW IT responses were separated into three subtypes depending on whether a word came to mind before the next trial began and if so whether the word was the same word specified by the definition or a different word. For the majority of DON'T KNOW IT responses, no word came to mind which further serves to disassociate DON'T KNOW IT responses from TOT responses. The two types of DON'T KNOW IT responses in which some word came to mind, DON'T KNOW IT (Same) and DON'T KNOW IT (Different), occurred on less than 2% of the trials and were excluded from further analysis.

DON'T KNOW IT (No word) responses were analyzed in one-way ANOVA with non-target type as a within-subject variable. There was no effect of non-target type (related: *M* = 11.6%, unrelated: *M* = 15.2%, blank: *M* = 12.4%).

Discussion

The purpose of Experiment 1 was to determine whether semantically related non-targets affected the frequency of TOT states. The results show that the probability of TOT states did not change as a function of the type of non-target nor is the probability of resolving a TOT affected by the type of non-target. Moreover, controlling for item difficulty, as suggested by A.

Brown, does not change these results.

It is clear however, that the provision of a semantically related non-target does increase the number of successful retrievals involving the intended word while decreasing the number of successful retrievals involving an unintended word. The effect may be due to semantic priming brought about by the activation of the non-target. It is more likely though, that the provision of a semantically related non-target allows the participant to rule out the non-target as a candidate which increases the probability of selecting the intended target. The instructions made it clear that the non-target would never be the word being defined. This interpretation is supported by the finding that the overall number of KNOW IT responses was not affected by non-target type. That is, a related non-target allows the participant to rule out the non-target as a possible target and simply alters the ratio of KNOW IT (Same) responses to KNOW IT (Different) responses without increasing the overall number of KNOW IT responses.

The present findings are of note because the semantically related non-targets were selected on the basis of normative data. Previous research has relied on thesauruses and/or intuition as a means of generating suitable non-targets. The use of normative data ensures that the related non-targets are relatively strong associates to the target. The findings are also of note because of the inclusion of a control condition in which a non-target was not presented as a means of assessing the effect of non-target presentation per se.

Although the results provide little support for the inadvertent activation hypothesis, it is possible that phonologically related non-targets are more likely to be inadvertently activated than semantically related non-targets. Experiment 2 addresses this possibility.

Experiment 2

In Experiment 2, the goal was to determine whether phonologically related non-targets increase or decrease TOT probability. The identical procedure and stimulus targets from Experiment 1 were used in Experiment 2 but instead of semantically related and unrelated non-targets, phonologically related and unrelated non-targets were used.

Method

Subjects. Sixty-five introductory psychology students participated in this experiment and received credit toward their research participation option. None of the students had participated in any previous studies involving TOT experience.

Materials. The same 28 experimental targets and four catch trial targets from Experiment 1 were used in the present experiment. (See Appendix 2.) For each experimental target, a phonologically related non-target was selected to match the target in initial letter, number of syllables and number of letters. Unrelated non-targets were matched to the target in the number of syllables and number of letters but differed in initial letter. None of the non-targets were semantically related to the corresponding targets and furthermore, none of the non-targets began with a vowel, a consonant cluster, or irregular orthography. All non-targets were relatively concrete nouns. The same catch trial non-targets from Experiment 1 were used for the catch trial targets.

In order to make comparisons between Experiment 1 and 2, the word frequency of each pair of phonological non-targets was matched to the word frequency of the corresponding semantic pair of non-targets from experiment 1. Thus, across experiments non-targets were matched for frequency, and differed from the target in either one or more of the following; meaning, number of syllables and initial letter.

The two master tapes from Experiment 1 were used to create 6 more cassette tapes by dubbing the phonologically related or unrelated non-targets after the tone following the definition. The order of non-target type on each cassette tape was identical to the order of the corresponding tape from Experiment 1. As before, across the three pairs of cassette tapes, each target definition was repeated three times and followed by all three possible non-targets.

Procedure. The administration of the task and the random assignment of participants to the cassette tapes was identical to the procedures used in Experiment 1. At the conclusion of the experiment, 21 participants had been assigned to the first set of cassette tapes, 21 to the second set, and 23 to the third set. The task instructions were identical to the instructions used in Experiment 1 except that participants were told that on some trials, the non-target would start with the same letter as the target.

Results

The frequency of the three basic response types was expressed as a percentage of the valid trials (i.e. trials in which the target was rated as familiar and the participant's response was interpretable) that occurred for each participant. The average number of valid trials per participant was 24.00 (out of 28 experimental targets).

KNOW IT Responses. KNOW IT responses occurred on 60.1% of the valid trials. The two types of KNOW IT responses, KNOW IT (Same) and KNOW IT (Different), were analyzed separately in one-way ANOVAs with non-target type as a within-subject variable. For KNOW IT (Same) responses, there was no effect of non-target type, (related: $\underline{M}$ = 41.1%, unrelated: $\underline{M}$ = 44.2%, blank: $\underline{M}$ = 37.2%). Similarly, there was no effect of non-target type in the analysis of KNOW IT (Different) responses, (related: $\underline{M}$ = 18.0%, unrelated: $\underline{M}$ = 19.6%, blank: $\underline{M}$ = 20.0%).

TOT Responses. Tip-of-the-tongue responses occurred on 24.9% of the valid trials. The TOT responses were separated into the four subtypes and Table 4 displays the percentage of trials in which information was correct, incorrect, or not provided at all for each of the five response types. Table 4 also lists for each response type the number of participants who reported having at least one such response.

As in Experiment 1, the composition of each subsample differs

Table 4

Accuracy of Information Provided by Participants in TOT States and DON'T KNOW IT States

	TOT Response Type				DON'T KNOW IT Response
	Same		Different		
	Unresolved	Resolved	Unresolved	Resolved	
	N = 48	N = 37	N = 47	N = 35	N = 58
BEGINNING SOUNDS					
% Correct	34.1	41.4		30.3	7.0
% Incorrect	8.5	5.0		6.3	21.2
% None Given	57.4	53.6	61.6	63.4	71.8
MIDDLE SOUNDS					
% Correct	5.1	6.9		4.3	3.5
% Incorrect	1.9	0.0		0.0	8.3
% None Given	93.0	93.1	90.5	95.7	88.2
END SOUNDS					
% Correct	14.2	6.3		13.8	1.8
% Incorrect	6.0	0.0		2.9	16.7
% None Given	79.8	93.7	83.3	83.3	81.5
NUMBER OF SYLLABLES					
% Correct	34.3	26.5		27.9	20.5
% Incorrect	20.0	8.1		10.0	21.0
% None Given	45.7	65.4	41.1	62.1	58.6
MEANING RELATED WORDS					
% Provided	40.5	22.7	30.5	26.5	23.5
SOUND RELATED WORDS					
% Provided	4.8	2.7	1.2	4.3	4.4

across the five response types making statistical test to compare response types inappropriate. The pattern of performance represented in Table 4 though, is very similar to the pattern found in Table 1 and adds support to the general conclusions that were drawn earlier for Experiment 1.

One additional finding from Table 4 is that even though participants were told that non-targets would be phonologically related, they still provided considerably more meaning related words than sound related words. This replicates the finding from Experiment 1 and adds further support to the claim that participants are inclined to activate semantically related words when in a TOT state.

Performance on the catch trials revealed that participants correctly recalled the non-target word 84.2% of the time. Although performance is less than what was found in Experiment 1, the results still suggest that the non-target was available on most trials during target retrieval.

Table 5 displays the percentage of valid trials that each TOT response occurred on as a function of non-target type. The first two TOT response types shown in Table 5, TOT (Same-Unresolved) and TOT (Same-Resolved), were analyzed in a two-way ANOVA with non-target type and resolution as within-subject variables. There was a significant effect of non-target type, F (2, 128) = 3.871, $p < .05$. There were fewer TOT (Same) responses when non-targets were unrelated (M = 9.8%) than when they were related (M = 14.6%) or blank (M = 16.1%). Table 5 shows that this effect occurred

Table 5

Percentage of TOT Response Types (out of all Retrieval Attempts) as a Function of Non-target Type

	Non-target Type		
TOT Response Type	Related	Unrelated	Blank
Same-Unresolved	9.0	5.4	9.1
Same-Resolved	5.5	4.3	7.0
Different-Unresolved	6.9	9.1	6.4
Different-Resolved	4.9	4.0	4.3

Table 6

Percentage of TOT Response Types (out of Unsuccessful Retrieval Attempts) as a Function of Non-target Type

	Non-target Type		
TOT Response Type	Related	Unrelated	Blank
Same-Unresolved	19.4	17.3	19.5
Same-Resolved	12.4	10.0	19.6
Different-Unresolved	18.6	27.2	16.3
Different-Resolved	11.5	10.1	8.4

regardless of whether the TOT state was resolved. There were no other significant effects.

In the analysis of TOT (Different-Unresolved) and TOT (Different-Resolved) responses, there was a significant effect of resolution, F (1, 64) = 11.246, p < .001. There were more TOT (Different-Unresolved) responses (M = 7.4%) than TOT (Different-Resolved) responses (M = 4.4%). Table 5 shows that this occurred regardless of the non-target type. There were no other significant effects.

Table 6 displays the percentage of unsuccessful retrieval attempts (i.e. excluding KNOW IT responses) that each TOT response type occurred on. Seven participants were excluded because they only provided KNOW IT responses. There were no significant effects in the analysis of TOT (Same-Unresolved) and TOT (Same-Resolved) responses from Table 6. Table 6 shows that non-target type does not affect TOT probability when performance is corrected for item difficulty.

There was a significant effect of resolution in the analysis of TOT (Different-Unresolved) and TOT (Different-Resolved) responses, F (1, 57) = 13.572, p < .001. Consistent with the earlier analysis, there were more TOT (Different-Unresolved) responses (M = 18.7) than TOT (Different-Resolved) responses (M = 10.0). Table 6 shows that this effect occurred regardless of the non-target type. There were no other significant effects.

DON'T KNOW IT Response. DON'T KNOW IT responses occurred on 15.1% of the valid trials. For the majority of DON'T KNOW IT responses, no word came to mind. DON'T KNOW IT responses in which some word came to mind occurred on less than 2% of the trials and were excluded from further analysis. DON'T KNOW IT (No word) responses were analyzed in one-way ANOVA with non-target type as a within-subject variable. The effect was not significant (related: M = 12.6%, unrelated: M = 12.2%, blank: M = 14.7%).

Discussion

The purpose of Experiment 2 was to determine whether phonologically related non-targets affect the frequency of TOT states. When the number of TOT states was examined relative to all retrieval attempts, there were fewer TOT (Same) states when phonologically unrelated non-targets were presented than when related non-targets or no non-targets were presented. However, when the number of TOT states was examined relative to only unsuccessful retrievals attempts, there were no differences in the number of TOT (Same) states as a function of non-target type. The type of non-target also had no effect on KNOW IT states and DON'T KNOW IT states. Thus, the results of the present research suggest that the phonological relationship between target and non-target has little effect on target retrieval and TOT probability.

The present findings differ from Askari (1991) who used a procedure based on Jones (1989) and Jones and Langford (1987) but without confounding item difficulty with non-target type. Askari (1991) also included a no non-target condition for assessing the effects of different non-targets on the probability of a TOT responses. Askari found that phonologically related non-targets increased the number of KNOW IT (Same) responses but did not affect the number of TOT responses. However, Askari presented the non-targets in blocks and participants may have been using the phonological information in a strategic manner. The present results suggest that the facilitation of KNOW IT responses in Askari's research was likely due to strategic factors.

The present findings also differed from the results of Jones and his colleagues (Jones & Langford, 1987; Jones, 1989) who reported that phonologically related non-targets increase the probability of a TOT state. As pointed out earlier, Jones confounded item difficulty with non-target type which is problematic for his conclusions. Moreover, Jones did not specify whether TOT states for different word were included in his analyses or whether TOT states that were resolved were included. Jones only differentiated between objective TOT states (participant provides at least one piece of correct information) and subjective TOT states (participant does not provide any correct information). Nevertheless, the present findings offer little support for the hypothesis that phonologically related non-targets increase TOT probability.

Finally, the results of the present experiment also provide little support for the hypothesis that TOT states arise because of incomplete activation (Brown & McNeill, 1966). Phonologically related non-targets should decrease the likelihood of a TOT state as they activate otherwise 'illegible features'. The present findings provide no support for this type of facilitation nor is there evidence for facilitation of successful retrievals. Moreover, the present experiment offers little support for the prediction made by Burke et al. (1991). Since the non-targets were always from the same syntactic class as the targets, the presentation of a phonologically related non-target should have delayed resolution of a TOT state relative to an unrelated non-target or no non-target. There was, however, no interaction between resolution and phonological relatedness.

General Discussion of Experiment 1 and 2

The results of Experiments 1 and 2 address two important and related questions. First, does the unintentional activation of non-targets increase the occurrence of TOTS in the manner suggested by and Jones and Langford (1987) or do they facilitate the successful retrieval of targets as suggested by Brown & McNeill (1966). Second, does the effect of a non-target on the occurrence of TOT states depend on whether the relationship between the target and non-target is phonological or semantic.

The results show quite clearly that non-targets have a minimal impact on the occurrence of TOT states, regardless of the relationship between target and non-target. If anything, non-targets facilitate the successful retrieval of targets without affecting the occurrence of TOT states, but only when the non-target is semantically related. This finding is inconsistent with the explanation offered Jones (1988), who suggested that TOT states occur when related words become unintentionally activated and interfere with the activation of the intended word. Jones and

Langford (1987) argued that the provision of a non-target immediately after the initiation of a word search should be functionally equivalent to unintentional activation and thus lead to more TOT states. The present findings, however, offer little support for the idea that TOT states are caused by unintentionally activated words.

It should be pointed out, though, that the procedure used in Experiment 1 and 2 may not have been appropriate as a test of the inadvertent activation hypothesis. Perhaps the provision of a non-target is not functionally equivalent to the inadvertent activation of an interfering 'blocker'. That is, the cause of TOT states may have something to do with the processes involved in or that lead to inadvertent activation rather than the presence of some non-target. Experiments 3, 4, and 5 addressed this concern by looking at different types of targets that may be differentially sensitive to TOT states.

The results of Experiment 2 also are inconsistent with the proposal put forth by Brown and McNeill (1966). Phonologically related non-targets did not facilitate the successful retrieval of intended targets nor did they lower TOT probability. The results of Experiment 2 also provide little support for the prediction made by Burke et al. There was no evidence that phonologically related non-targets affected the resolution of TOT more than phonologically unrelated non-target. Moreover, both Brown and McNeill (1966) and Burke et al. (1991) cannot explain why semantically related non-targets facilitate the successful retrieval of targets without making additional assumptions. This facilitation is noteworthy because, unlike previous studies, the present research relied on normative data for the selection of semantically related non-targets to ensure a strong semantic association between target and non-target.

The lack of facilitation from phonologically related non-targets in Experiment 2 is somewhat surprising in light of previous research (Askari, 1991). However, it may be that the facilitation reported by Askari arose because of strategic factors. Askari's non-targets were in blocked presentations so that participants always knew when to use the first letter of the non-target as cue to aid retrieval. Similarly, Bowles and Poon (1985b) found a similar type of facilitation when they presented first letter primes prior to a definition in a study of semantic inhibition. Again, the conditions of the study were such that participants always knew that single letter primes were the first letter of the target.

The findings from both experiments are notable because there were several improvements in the methodology typically used in TOT research. First, the results were based only upon trials in which targets were potentially retrievable. That is, responses were included in the analyses only if the word being defined was familiar to the participant. Previous studies typically utilize low frequency and/or uncommon words and it is likely that a significant proportion of these words would be unfamiliar to participants. Analyzing the results of trials involving familiar words partially controls for the individual differences in vocabulary knowledge and reduces the error variance. Moreover, the incidence of TOT states is likely underestimated without correcting for target familiarity.

A second improvement in the present research was the use of catch trials to ensure that non-targets would be 'available' during target retrieval. Without catch trials, it is unclear whether participants in previous research were actually processing non-targets and or whether non-targets were available during the retrieval of the target word.

Third, the present research examined four of the TOT subtypes that were identified by Koriat and Lieblich (1974). Previous research has not been consistent in type of TOT states that were reported (i.e. whether they were resolved and if the word being sought was the word intended by the experimenter). The results of the present show that the quantity and quality of information provided in each of the four subtypes was remarkably stable across experiments, a finding that justifies the inclusion of all TOT subtypes for analysis.

Target Type and TOT Probability

The next three experiments were designed to test predictions generated by the two competing interpretations (inadvertent activation vs. incomplete activation) regarding TOT susceptibility for different types of targets. According to Brown and McNeill (1966), the phonological information associated with low frequency words often is not 'legible' and consequently, such words are more susceptible to TOT states. Similarly, Burke et al. (1991) stated that frequency affects the likelihood of a TOT state by determining the strength of the connections between lexical nodes to phonological nodes. Low frequency words have weaker connections and as a result, the transmission of priming to the phonological level is reduced. In Experiment 3, the effect of word frequency was examined directly for its relationship to TOT states.

According to the inadvertent activation view some words may be more prone to a TOT state because they have more 'neighbours' that are likely to become activated during word retrieval and hence interfere with or block access to the intended target. In order to test this prediction, two experiments were carried out. In Experiment 4, TOT probability was compared across two groups of targets that differed in the number of phonologically related neighbours associated with each target. In Experiment 5, TOT probability was compared across two groups of targets that differed in the number of lexically related neighbours associated with each target.

Experiment 3

The third experiment was designed to test whether word frequency was related to the probability of a TOT state. It is somewhat surprising to note that there has been no direct investigation of whether the word frequency affects the occurrence of TOT states. It also is somewhat alarming because as pointed out by A. Brown (1991), a fundamental assumption dominating all research in this area is that TOT probability is 'inversely related to the normative frequency of the targets'. In a study of TOT states recorded in diaries, Burke et al. (in press) reported that the median frequency of TOT targets was considerably lower than would be expected by chance. In other diary studies, however, Reason and Lucas (1984) and Cohen and Faulkner (1986) both reported that the targets being sought by people in a TOT state were often rated as being very familiar or well known. Although the relation between frequency and familiarity is not necessarily isomorphic (see Gernsbacher, 1984), clearly, there is a need to examine directly whether word frequency affects the occurrence of TOT states.

In addition to word frequency, Burke et al. (1991) claimed that the strength of the connections to phonological information is affected by the recency of activation. They assumed that the strength of the connection is weakened with the passage of time and that TOT states are more likely to occur for words that have not been used recently. In support of this claim, Burke et al. (1991) found that adults often reported TOT states for the names of persons that had not contacted for some time.

It should be noted that recency of activation and frequency are closely related because high frequency words are activated more often and hence have a higher probability of being activated more recently than low frequency words. Aside from Burke et al. (1991) there has been no effort to examine recency of activation and its relation to TOT states independent of word frequency. In the present study, participants were asked to estimate the duration of time since a target was last used as a means of examining the relation between recency of activation and TOT states as well as successful and unsuccessful retrieval attempts (i.e. KNOW IT and DON'T KNOW responses).

In the present experiment, the basic paradigm from the previous experiments was used to induce TOT states except that non-targets were not presented after the definitions. Also, after participants indicated whether the word was familiar, they were asked to indicate how long it had been since they last used the word if it was familiar. Half the words were relatively high frequency words whereas the other half were carefully matched low frequency words. According to Brown and McNeill (1966) and Burke et al. (1991), more TOT states should occur for low frequency words than for high frequency words. Moreover, according to Burke et al. (1991), recency of activation estimates should be higher for words that lead to TOT states than for words that are successfully retrieved.

Method

Subjects. Forty introductory psychology students participated in this experiment and received credit toward their research participation option. None of the participants had participated in any previous studies involving TOT experiences.

Materials. Fifteen low frequency words were selected from Kucera and Francis (1967) with each word having a frequency of occurrence of 2 per million or less. For each low frequency word, a high frequency word was selected so that both words were matched as close as possible for the number of syllables, the number of letters, and the first letter. The group of high frequency words ranged in frequency from 17 to 48 with an average frequency of occurrence 30.9. All words were relatively concrete nouns and none of the words began with a vowel (e.g. aviary), consonant cluster (e.g. crater) or irregular orthography (e.g. gnome). (See Appendix 3.) The definitions were derived from the Concise Oxford Dictionary of Current English (7th Edition).

The 30 words were divided into two lists, A and B, that were balanced for word frequency and number of syllables. Furthermore, matched words that differed only in frequency were never in the same list. The order of items on each list was randomly determined with the only exception that no more than 3 words of one type could occur in a row.

For both lists, the definitions for each word were read aloud by a female graduate student and recorded on a normal bias cassette tape. Each definition was preceded by the word 'Definition' and was followed by approximately 50 seconds of silence. Each list was recorded on a separate tape. The definitions were presented to the participants in one of two orders (A-B or B-A).

Procedure. The same procedure from the previous two experiments was used with the following modifications. First, there were no non-targets presented after the definitions so the average time between trials was slightly longer. Second, after participants indicated whether the word was familiar, they were then asked to estimate how long it had been since they used the intended target by circling one of 6 durations; 1 month, 3 months, 6 months, 1 year, 3 years, 5 years. The examiner stressed that 'using the word' included any instance of reading, writing, hearing, or speaking the word.

Results

The frequency of the three basic response types, TOT, KNOW IT, and DON'T KNOW IT was expressed as a percentage of valid trials. The average number of valid trials for each participant was 26.5 out of 30. Each response type was separated into subtypes and analyzed separately.

KNOW IT Responses. KNOW IT responses occurred on 70.0% of the valid trials. KNOW IT responses were separated into the two subtypes, KNOW IT (Same) and KNOW IT (Different), and analyzed separately because the word frequency manipulation cannot be interpreted in the same way for the two subtypes. That is, the frequency of the target retrieved in KNOW IT (Same) is known whereas the frequency of the target retrieved in KNOW IT (Different) responses varies from participant to participant.

For KNOW IT (Same) responses, there was a significant effect of word frequency, t (37) = 3.019, $p < .01$. There were more KNOW IT (Same) responses for high frequency words (M = 56.2%) than for low frequency words (M = 46.4%). Not too surprisingly, this finding suggests high frequency words are easier to retrieve than are low frequency words.

There also was a significant effect of word frequency in the analysis of KNOW IT (Different) responses, t (37) = 2.655, $p < .05$, even though the actual responses varied in word frequency. This time however, there were fewer KNOW IT (Different) responses for high frequency words ($M = 14.9\%$) than for low frequency words ($M = 22.2\%$). This finding suggests that the definitions for low frequency words may be relatively more ambiguous compared to the definitions to high frequency words. As a result, there is more variance in the type of target that is retrieved.

TOT Responses. Tip-of-the-tongue responses occurred on 18.8% of the valid trials. The TOT responses were separated into the four subtypes and Table 7 displays the amount and accuracy of information provided by participants for the 5 different response types. The first row in Table 7 displays the number of participants who experienced at least one such response type and this subsample was used to calculate the percentage of valid trials in which information was correct, incorrect, or not provided for the four different word properties. Table 7 also lists the percentage of participants in each subsample that provided one or more meaning related word and one or more sound related word for each response type.

The means in Table 7 replicate the pattern of means in Tables 1 and 4 and further serve to support the conclusions that were drawn earlier regarding the difference between TOT responses and DON'T KNOW IT responses and the justification for including TOT responses in the analyses.

Table 8 lists the percentage of each TOT response type as a

Table 7

Accuracy of Information Provided by Participants in TOT States and DON'T KNOW IT States

	TOT Response Type				DON'T KNOW IT Response
	Same		Different		
	Unresolved	Resolved	Unresolved	Resolved	
	N = 24	N = 20	N = 27	N = 21	N = 34
BEGINNING SOUNDS					
% Correct	35.0	21.9		35.6	12.0
% Incorrect	19.4	7.5		4.8	25.8
% None Given	45.4	70.6	53.7	59.7	61.6
MIDDLE SOUNDS					
% Correct	11.1	2.5		3.2	6.7
% Incorrect	0.1	5.0		4.8	6.8
% None Given	87.7	92.5	80.9	92.1	86.5
END SOUNDS					
% Correct	21.2	10.0		16.2	1.7
% Incorrect	9.0	5.0		9.5	30.2
% None Given	69.8	85.0	69.8	74.3	68.0
NUMBER OF SYLLABLES					
% Correct	35.7	32.3		24.3	18.2
% Incorrect	28.1	0.0		16.7	21.6
% None Given	36.3	67.7	39.5	59.0	60.2
MEANING RELATED WORDS					
% Provided	45.1	25.8	43.0	16.2	30.9
SOUND RELATED WORDS					
% Provided	4.2	0.0	2.5	1.0	0.7

Table 8

Percentage of TOT Response Types (out of all Retrieval Attempts) as a Function of Word Frequency

	Word Frequency	
TOT Response Type	High	Low
Same-Unresolved	5.4	6.1
Same-Resolved	3.6	3.6
Different-Unresolved	4.0	6.6
Different-Resolved	5.0	3.1

Table 9

Percentage of TOT Response Types (out of Unsuccessful Retrieval Attempts) as a Function of Word Frequency

	Word Frequency	
TOT Response Type	High	Low
Same-Unresolved	16.9	19.9
Same-Resolved	10.4	13.7
Different-Unresolved	13.6	20.7
Different-Resolved	19.2	11.5

function of word frequency. The first two TOT subtypes in Table 8, TOT (Same-Unresolved) and TOT (Same-Resolved), were analyzed in a two-way ANOVA with word frequency (low vs. high) and resolution (unresolved vs. resolved) as within-subject variables. Neither variable was significant, nor was the interaction significant.

The next two TOT subtypes, TOT (Different-Unresolved) and TOT (Different-Resolved), were analyzed in an identical ANOVA. There were no significant effects of word frequency or resolution but there was a significant interaction between the two variables, $F(1,37) = 5.059$, $p < .05$. As shown in Table 8, there were more TOT (Different-Unresolved) responses when definitions of low frequency words were presented than when definitions of high frequency words were presented whereas the opposite was true for TOT (Different-Resolved) responses. Unfortunately though, the interaction is hard to interpret because the actual frequency of the word involved in the TOT state is unknown.

The percentage of TOT states also was calculated relative to unsuccessful retrievals as a means of controlling for differences in item difficulty. These percentages are shown in Table 9 for the four TOT subtypes. The data from two participants were removed because they only provided KNOW IT response.

The first two TOT subtypes in Table 9, TOT (Same-Unresolved) and TOT (Same-Resolved), were analyzed in a two-way ANOVA. There were no significant effects. The next two TOT subtypes, TOT (Different-Unresolved) and TOT (Different-Resolved), also were analyzed in a two-way ANOVA. Neither main effect was significant but the interaction between the word frequency and resolution was marginally significant, F (1,35) = 3.965, $p < .06$. The pattern of means in this interaction are shown in Table 9 and are identical to the pattern of means in Table 8. Again though, caution must be exercised when interpreting the effect of word frequency or its interaction for responses in which the frequency of the target is not known.

DON'T KNOW IT Responses. DON'T KNOW IT responses occurred on 11.2% of the valid trials. DON'T KNOW IT responses were separated into the three subtypes. As in Experiments 1 and 2, the clear majority of DON'T KNOW IT responses were ones in which no word came to mind. The other two subtypes occurred on less than 2% of the valid trials and were excluded from further analyses.

A t-test was used to determine if word frequency affected the percentage of DON'T KNOW IT (No word) responses. Participants were just as likely to provide a DON'T KNOW IT response regardless of word frequency (High frequency word: M = 9.5%, Low frequency word: M = 10.3%).

Duration Estimates. Table 10 displays the estimated duration since the target was last used as a function of word frequency for four different response types. Three of the response types, KNOW IT (Same), TOT (Same-Unresolved) and TOT (Same-Resolved) were responses that involved the word intended by the experimenter. The estimates associated with DON'T KNOW IT (No word) responses were included for comparison purposes. Table 10 also lists the number of participants upon which the estimates were based for each

Table 10

Estimated Duration (in months) Since Targets Were Last Used as a Function of Response Type and Word Frequency

	Word Frequency	
TOT Response Type	High	Low
KNOW IT (Same)	N = 38 2.57	N = 38 5.47
TOT (Same-Unresolved)	N = 20 5.60	N = 18 9.09
TOT (Same-Resolved)	N = 12 6.33	N = 12 9.80
DON'T KNOW IT (No word)	N = 25 4.67	N = 29 21.16

response type.

Statistical tests were not undertaken to make comparisons across items or across response types because the composition of the subsample differed across word frequency type and response type. Nevertheless, there are two general observations that can be drawn from Table 10. First, the estimates associated with high frequency words are much lower than the estimates associated with low frequency words, a finding that would be expected on the basis of the frequency manipulation.

Second, for low frequency words, the duration since a word was last used appeared to be smallest for KNOW IT (Same) responses, intermediate for TOT (Same-Unresolved) and TOT (Same-Resolved) states and largest for DON'T KNOW IT states. This observation was replicated in Experiments 4, 5 and 6 and appeared to be a reliable phenomenon.

Discussion

Surprisingly, there was no effect of word frequency on the occurrence of a TOT state. Brown and McNeill (1966) and Burke et al. (1991) both suggested that low frequency words should entail more TOT states than high frequency words. The present results do not support this prediction. It is possible that the frequency manipulation was not strong enough to test this prediction. The range of high frequency targets was relatively small (17 to 48 occurrences per million) and below the median frequency of all open class words in Francis and Kucera (1967) (84 occurrences per million). Nevertheless, frequency effects were found in other measures such as the number of KNOW IT (Same) responses and the duration estimates.

There was some evidence to indicate that lower frequency words were associated with more TOT (Different-Unresolved) responses, or as Brown and McNeill (1966) call them, 'negative TOT states'. The interpretation of this finding is difficult because the word frequency manipulation is only meaningful for targets intended by the experimenter. For TOT (Different-Unresolved) responses, the frequency of the word being sought is unknown.

A similar problem of interpretation exists in the analysis of KNOW IT (Different) responses which were greatest for low frequency words. One possibility is that the more 'ambiguous' a definition is (as indicated by the number of KNOW IT (Different) responses), the more likely there will be a TOT (Different-Unresolved) responses. This possibility will be discussed in greater detail in the fifth experiment.

The duration estimates provided some support for the model by Burke et al. (1991) in which recency of activation is a contributing factor affecting the strength of the connections between lexical and phonological information. Words that have not been used for a long period of time will have weaker connections and hence be more susceptible to TOT states. This explains why the estimated durations associated with TOT (Same) states are larger than the estimated durations associated with KNOW IT (Same) states. It is unclear, however, why the estimated durations associated with TOT (Same-Resolved) response are almost identical to the estimated durations associated with TOT (Same-Unresolved) responses. It seems reasonable to predict that TOT states that are resolved would be associated with targets that have been used more recently in comparison to TOT states that are unresolved. This prediction rests on the assumption that the probability of a TOT resolution is a function of the connection strength to phonological information. Targets that have been used more recently have greater connection strength and thus are more likely to be resolved.

There are some caveats with the duration estimates and the most obvious being that the duration estimates are subjective self reports and may not be based entirely on the passage of time. For instance, it may be that the act of successful retrieval influences the estimation process for KNOW IT responses. When words are easily retrieved, duration may appear subjectively shorter. Similarly, when words are harder to retrieve, duration may appear subjectively longer. Nevertheless, the pattern of means are suggestive and warrant further examination.

Experiment 4

The fourth experiment was designed to examine whether the number of phonologically related neighbours was related to TOT probability. According to the inadvertent activation view, the more phonologically related neighbours that are present, the more likely that one neighbour may become inadvertently activated and interfere with the activation intended for the target. Thus, as the number of phonologically related neighbours increases, the probability of a TOT state should increase as well. Targets with few phonologically related neighbours can be thought of as phonologically distinct and hence less susceptible to TOT states.

In the present experiment, the same procedure from Experiment 3 was used except phonological distinctiveness was manipulated. Half the words were low in phonologically distinctiveness and the other half were high in phonological distinctiveness. Digram frequency counts (Mayzner & Tresselt, 1965) were used to estimate the number of words that began with the first two letters of each target. The total number of words were added together and used to estimate the number of phonological neighbours associated with each target. Targets with many neighbours were assumed to be low in phonological distinctiveness whereas targets with few neighbours were assumed to be high in phonological distinctiveness. If the number of phonologically related neighbours is positively related to TOT probability, then targets that are low in distinctiveness should produce more TOT states than targets that are high in distinctiveness.

Method

Subjects. Forty introductory psychology students participated in this experiment and received credit toward their research participation option. None of the participants had participated in any previous studies involving TOT experiences.

Materials. Thirty targets were selected from the corpus of materials used in previous three experiments. (See Appendix 4.) All targets had a frequency of occurrence of 5 per million or less. All items were relatively concrete nouns and none of the words began with a vowel (e.g. aviary) consonant cluster (e.g. crater) or irregular orthography (e.g. gnome). Digram frequency counts were used to estimate the number of phonologically related neighbours associated with each target. The number of 3-, 4-, 5-, 6-, & 7-letter words that began with the first two letters of each target was determined and summed together as an estimate of the number of phonologically related neighbours. The number of phonological neighbours for all targets ranged from 0 to 519 with an average number of neighbours of 182.4 and a median number of neighbours of 162.5. Targets that had more than the median number of neighbours were placed in the high phonological distinctiveness target group (average number of neighbours = 280.1) and the remaining targets were placed in the low phonological distinctiveness target group (average number of neighbours = 84.7). Both groups of words were matched as closely as possible for the number of syllables, letters and targets that began with the same letter.

The 30 words were divided into two lists (A and B) and each list was balanced for the number of syllables, number of letters, and phonological distinctiveness. The order of items in each list was randomly determined with the only exception that no more than 3 words of high or low phonological distinctiveness could occur in a row. The same procedure from Experiment 1 was used to prepare the cassette tapes.

Procedure. The same procedure from Experiment 3 was used.

Results

The frequency of each response type was expressed as a percentage of valid trials for each participant. The average number of valid trials per participant was 25.43 out of 30 trials.

KNOW IT Responses. KNOW IT responses occurred on 62.4% of the valid trials. KNOW IT responses were separated into the two subtypes and analyzed separately. For KNOW IT (Same) responses, there was no effect of phonological distinctiveness (low phonological distinctiveness: $\underline{M}$ = 41.7%, high phonological distinctiveness: $\underline{M}$ = 44.8%). Similarly, there was no effect of phonological distinctiveness in the analysis of KNOW IT (Different) responses (low phonological distinctiveness: $\underline{M}$ = 21.1%, high phonological distinctiveness: $\underline{M}$ = 17.4%)

TOT Responses. Tip-of-the-tongue responses occurred on 22.8% of the valid trials. Tip-of-the-tongue responses were separated into the four subtypes and Table 11 summarizes the nature of the information provided by participants for each of the 5 response types. The pattern of means is once again virtually identical to the pattern of means reported in the previous experiments and further supports the general conclusions that were drawn earlier.

Table 12 lists the percentage of valid trials for each TOT subtype as a function of phonological distinctiveness. The first two TOT subtypes, TOT (Same-Unresolved) and TOT (Same-Resolved), were analyzed in a two-way ANOVA with phonological distinctiveness (high vs. low) and resolution (resolved vs. unresolved) as within-subject variables. The effect of phonological

Table 11

Accuracy of Information Provided by Participants in TOT States and DON'T KNOW IT States

	TOT Response Type				DON'T KNOW IT Response
	Same		Different		
	Unresolved	Resolved	Unresolved	Resolved	
	N = 28	N = 24	N = 30	N = 20	N = 36
BEGINNING SOUNDS					
% Correct	31.9	29.2		34.2	2.4
% Incorrect	14.8	6.3		1.3	25.6
% None Given	53.3	64.6	54.6	64.5	72.0
MIDDLE SOUNDS					
% Correct	14.7	15.3		11.0	6.8
% Incorrect	12.3	0.0		0.0	10.2
% None Given	73.0	84.7	72.1	89.0	83.0
END SOUNDS					
% Correct	22.2	8.0		24.5	2.1
% Incorrect	11.3	4.2		0.0	21.5
% None Given	66.5	87.8	67.2	75.5	76.4
NUMBER OF SYLLABLES					
% Correct	45.1	34.7		33.5	11.1
% Incorrect	24.0	9.7		12.5	26.6
% None Given	30.9	55.6	46.4	54.0	62.3
MEANING RELATED WORDS					
% Provided	29.8	26.0	27.9	22.3	24.2
SOUND RELATED WORDS					
% Provided	7.1	2.8	0.0	0.0	0.0

Table 12

Percentage of TOT Response Types (out of all Retrieval Attempts) as a Function of Phonological Distinctiveness

	Phonological Distinctiveness	
TOT Response Type	High	Low
Same-Unresolved	6.3	8.9
Same-Resolved	4.9	6.2
Different-Unresolved	7.0	5.9
Different-Resolved	3.2	3.2

Table 13

Percentage of TOT Response Types (out of Unsuccessful Retrieval Attempts) as a Function of Phonological Distinctiveness

	Phonological Distinctiveness	
TOT Response Type	High	Low
Same-Unresolved	18.0	23.0
Same-Resolved	12.5	14.9
Different-Unresolved	17.5	17.7
Different-Resolved	7.2	6.9

distinctiveness approached significance, F (1,39) = 3.111, $p < .10$. There was a trend for more TOT (Same) responses to occur when targets were low in phonological distinctiveness (M = 15.1%) than when targets were high in phonological distinctiveness (M = 11.2%). Table 12 shows that this occurred regardless of the whether the TOT state was resolved. There were no other significant effects.

The other two TOT subtypes, TOT (Different-Unresolved) and TOT (Different-Resolved), were analyzed in an identical ANOVA. There was a significant effect of resolution, F (1,39) = 8.025, $p < .01$. There were more TOT (Different-Unresolved) responses (M = 6.5%) than TOT (Different-Resolved) responses (M = 3.3%). Table 12 shows that this occurred regardless of the level of phonological distinctiveness.

The occurrence of TOT states also was examined relative to unsuccessful retrievals (i.e. excluding KNOW IT responses) as a means of controlling for item difficulty. Table 13 lists the percentage of TOT states relative to unsuccessful retrievals. The first two TOT subtypes, TOT (Same-Unresolved) and TOT (Same-Resolved) were analyzed in a two-way ANOVA. Again, the effect of phonological distinctiveness approached significance F (1,39) = 3.628, $p < .07$. There was a trend for more TOT (Same) responses to occur when targets were low in phonological distinctiveness (M = 37.9%), than when targets were high in phonological distinctiveness (M = 30.4%). Table 13 shows that this effect occurred regardless of whether the TOT state was resolved.

There were no other significant effects.

The other two TOT subtypes, TOT (Different-Unresolved) and TOT (Different-Resolved), also were analyzed in a two-way ANOVA. There was a significant effect of resolution, F (1,39) = 9.112, $p < .01$. There were more TOT (Different-Unresolved) responses (M = 17.1%) than TOT (Different-Resolved) responses (M = 7.4%). Table 13 shows that this occurred regardless of the level of phonological distinctiveness.

DON'T KNOW IT Responses. DON'T KNOW IT responses occurred on 14.7% of the valid trials. DON'T KNOW IT responses were separated into the three subtypes. The majority of DON'T KNOW IT responses were ones in which no word came to mind. The other two subtypes occurred on less than 3% of the valid trials and were excluded from further analyses.

A t-test was used to examine the effect of phonological distinctiveness on DON'T KNOW IT (No word) responses. Participants were just as likely to provide a DON'T KNOW IT (No word) response regardless of phonological distinctiveness (high phonological distinctiveness: M = 14.1%, low phonological distinctiveness: M = 12.2%).

Duration Estimates. Table 14 displays the estimated duration since the target was last used as a function of word frequency for the four response types. The number of participants upon which the estimates for each response type are based also is shown.

As in the previous experiment, statistical tests were not undertaken to make comparisons between response types or target

Table 14

Estimated Duration (in months) Since Targets Were Last Used as a Function of Response Type and Phonological Distinctiveness

	Phonological Distinctiveness	
TOT Response Type	High	Low
KNOW IT (Same)	N = 37 4.58	N = 35 5.78
TOT (Same-Unresolved)	N = 20 12.10	N = 22 9.02
TOT (Same-Resolved)	N = 15 13.33	N = 19 10.97
DON'T KNOW IT (No word)	N = 35 17.07	N = 27 20.87

type because the composition of participants in each subsample differed across all means. The pattern of estimates is very similar to the pattern of means found in Experiment 3 for low frequency words and same general conclusion can be drawn. Namely, the duration since a word was last used appeared to be smallest for KNOW IT (Same) responses, intermediate for TOT (Same-Unresolved) and TOT (Same-Resolved) states and largest for DON'T KNOW IT states. It also should also be pointed out that there were no apparent differences in the duration estimates as a function of phonological distinctiveness regardless of response type.

Discussion

The findings of the present experiment offer some support for the inadvertent activation hypothesis. There was a trend for targets low in phonologically distinctiveness to be associated with a greater number of TOT states, but the effect only approached statistical reliability. Presumably, targets that are low in phonological distinctiveness have more phonological neighbours that could potentially interfere with activation. The present study, however, did not directly determine whether non-targets were actually activated during TOT states. Moreover, the number of participants who reported sound related words coming to mind was extremely low for both types of targets. If phonological neighbours were activated, one might anticipate a higher proportion of participants would report sound related words coming to mind especially when targets were low in phonological distinctiveness.

On the other hand, it is not entirely clear how this finding can be accounted for by the incomplete activation hypothesis. Both Brown and McNeill (1966) and Burke at al. (1991) would presumably argue that TOT probability is unrelated to the number of phonological neighbours. The number of neighbours should have no effect on the connection strength between lexical and phonological nodes.

The duration estimates again offer mixed support for the Burke et al. (1991) model. The difference between estimates associated with KNOW IT (Same) states and TOT (Same) states is consistent with the model. The lack of difference between the estimates associated with TOT (Same-Unresolved) and TOT (Same-Resolved) however, is inconsistent their model for reasons mentioned in the discussion section of Experiment 3.

Experiment 5

The fifth experiment was designed to test whether the number of lexically related neighbours was related to TOT probability. According to the inadvertent activation view, the more lexically related neighbours associated with a particular target, the more likely that one of the neighbours will become unintentionally activated and usurp the activation intended for the target. Thus, as the number of lexically related neighbours increases, the probability of a TOT state should increase as well. Targets with few lexically related neighbours can be thought of as lexically distinct and hence less susceptible to TOT states.

In the present experiment, the same procedure from Experiments 3 and 4 was used except lexical distinctiveness was manipulated. Half the words in the present experiment were low in lexical distinctiveness and the other half were high in lexical distinctiveness. The degree of lexical distinctiveness was determined using the data from the normative study conducted prior to Experiment 1. The ease with which a synonym could be generated for each target served as a measure of lexical distinctiveness. Targets for which no synonym could be generated were considered to be high in lexically distinctiveness (e.g. mermaid) whereas targets for which many synonyms could be generated were considered to be low in lexical distinctiveness (e.g. mentor). If lexical distinctiveness is related to TOT states, then targets that are low in distinctiveness should lead to more TOT states than targets that are high in distinctiveness.

Method

Subjects. Forty-two introductory psychology students participated in this experiment and received credit toward their research participation option. None of the participants had participated in any previous studies involving TOT states.

Materials. Thirty targets were selected from the normative study conducted earlier. (See Appendix 5.) All the words had a frequency of occurrence of 5 per million or less (Kucera & Francis, 1967). All the words were relatively concrete nouns and none of the words began with a vowel (e.g. aviary), consonant cluster (e.g. crater) or irregular orthography (e.g. gnome). Data from the normative study was used to estimate the degree of lexical distinctiveness. The proportion of participants who could not generate a synonym in response to an item (even though they were familiar with the item) was taken to reflect the degree of lexical distinctiveness for that item. If very few participants generated a synonym for an item, the item was assumed to be high in lexical distinctiveness. If many participants provided a synonym for an item, the item was considered to be low in lexical distinctiveness.

For the 15 targets that were high in lexical distinctiveness, only 73.7% of the sample in the normative study provided a synonym. For the 15 targets that were low in lexical distinctiveness, 88.1% of the sample provided a synonym. Each target high in lexical distinctiveness was matched to a target low in lexical distinctiveness as closely as possible in the number of syllables, the number of letters, and the beginning letter.

As in the previous two experiments, the 30 targets were divided into two lists (A and B) such that each list of words was balanced for number of syllables and the number of high and low lexically distinct targets. The order of items in each list was randomly determined with the only exception that no more than 3 words of high or low lexical distinctiveness could occur in a row. The same procedure from the previous two experiments was used to prepare the cassette tapes.

Procedure. The same procedure from Experiments 3 and 4 was used.

Results

The frequency of each response type was expressed as a percentage of valid trials for each participant. The average number of valid trials per participant was 25.29 out of 30 trials.

KNOW IT Responses. KNOW IT responses occurred on 58.3% of the valid trials. KNOW IT responses were separated into the two subtypes and analyzed separately. For KNOW IT (Same) responses, there was a significant effect of lexical distinctiveness, t (41) = 8.770, $p < .001$. There were more KNOW IT (Same) responses when targets were high in lexical distinctiveness (M = 50.2%) than when they were low in lexical distinctiveness (M = 25.7%).

For KNOW IT (Different) states, there also was a significant effect of lexical distinctiveness, t (41) = 9.026, $p < .001$. This time, however, there were fewer KNOW IT (Different) responses when targets were high in lexical distinctiveness (M = 9.1%) than when they were low in lexical distinctiveness (M = 31.7%).

TOT Responses. Tip-of-the-tongue responses occurred on 27.0% of the valid trials. The TOT responses were separated into the four subtypes and Table 15 summarizes the nature of the information provided by participants for each of the 5 responses types. Again, the pattern of means is identical to the pattern of means reported in the previous experiments and further supports the general conclusions that were drawn earlier.

Table 16 lists the percentage of valid trials that each TOT response occurred on as a function of lexical distinctiveness. The first two TOT subtypes, TOT (Same-Unresolved) and TOT

Table 15

Accuracy of Information Provided by Participants in TOT States and DON'T KNOW IT States

	TOT Response Type				DON'T KNOW IT Response
	Same		Different		
	Unresolved	Resolved	Unresolved	Resolved	
	N = 34	N = 28	N = 36	N = 27	N = 39
BEGINNING SOUNDS					
% Correct	33.5	35.8		19.8	3.8
% Incorrect	15.5	0.0		6.4	23.8
% None Given	51.0	64.2	63.7	73.8	72.4
MIDDLE SOUNDS					
% Correct	15.0	4.8		7.4	1.7
% Incorrect	7.5	1.8		5.6	7.2
% None Given	77.5	93.5	91.8	87.0	91.2
END SOUNDS					
% Correct	10.1	13.1		18.6	2.4
% Incorrect	7.4	2.4		1.9	15.4
% None Given	82.5	84.5	79.3	79.5	82.3
NUMBER OF SYLLABLES					
% Correct	39.2	34.3		21.9	16.8
% Incorrect	25.2	8.3		12.0	16.3
% None Given	35.6	57.3	57.7	66.0	66.9
MEANING RELATED WORDS					
% Provided	28.2	17.7	34.6	15.1	22.6
SOUND RELATED WORDS					
% Provided	6.8	8.0	1.1	1.0	0.0

Table 16

Percentage of TOT Response Types (out of all Retrieval Attempts) as a Function of Lexical Distinctiveness

	Lexical Distinctiveness	
TOT Response Type	High	Low
Same-Unresolved	7.6	7.2
Same-Resolved	7.1	3.0
Different-Unresolved	6.9	11.5
Different-Resolved	4.0	6.7

Table 17

Percentage of TOT Response Types (out of Unsuccessful Retrieval Attempts) as a Function of Lexical Distinctiveness

	Lexical Distinctiveness	
TOT Response Type	High	Low
Same-Unresolved	17.5	16.1
Same-Resolved	17.4	6.1
Different-Unresolved	16.7	26.8
Different-Resolved	10.3	18.0

(Same-Resolved), were analyzed in a two-way ANOVA with lexical distinctiveness (high vs. low) and resolution (resolved vs. unresolved) as within-subject variables. As shown in Table 16, there appeared to be an interaction between resolution and lexical distinctiveness but the effect was only marginally significant, $\underline{F}$ (1,41) = 3.374, $\underline{p} < .08$.

The remaining two TOT responses, TOT (Different-Unresolved) and TOT (Different-Resolved), were analyzed in an identical ANOVA. There was a significant effect of lexical distinctiveness, $\underline{F}$ (1,41) = 10.629, $\underline{p} < .01$. There were fewer TOT (Different) responses when targets were high in lexical distinctiveness ($\underline{M}$ = 10.9%) than when targets were low in lexical distinctiveness ($\underline{M}$ = 18.2%). Table 16 shows that this effect occurred regardless of whether the TOT state was resolved. There also was a significant effect of resolution, $\underline{F}$ (1,41) = 8.875, $\underline{p} < .01$. There were more TOT (Different-Unresolved) responses ($\underline{M}$ = 9.1%) than TOT (Different-Resolved) responses ($\underline{M}$ = 5.2%) and Table 16 shows that this occurred regardless of the level of lexical distinctiveness.

A similar pattern of results emerged in the analysis of TOT responses when the percentages were calculated relative to unsuccessful retrievals (i.e. excluding KNOW IT responses) in order to control for item difficulty. These percentages are shown in Table 17. The data from two participants were removed because they only provided KNOW IT response.

In the analysis of TOT (Same-Unresolved) and TOT (Same-Resolved) responses, there was a significant effect of lexical distinctiveness, F (1,39) = 7.642, $p < .01$. There were more TOT (Same) responses when targets were high in lexical distinctiveness (M = 34.9%) than when targets were low in lexical distinctiveness (M = 22.1%). There was, however, a significant interaction between lexical distinctiveness and resolution, F (1,39) = 4.338, $p < .05$. Table 17 shows quite clearly that the lexical distinctiveness effect occurred only for TOT (Same-Resolved) responses.

In the analysis of TOT (Different-Unresolved) and TOT (Different-Resolved) responses, there was a significant effect of lexical distinctiveness, F (1,39) = 12.033, $p < .001$. There were more TOT (Different) responses when targets were low in lexical distinctiveness (M = 44.7%) than when targets were high in lexical distinctiveness (M = 27.0%). Table 17 shows that this effect occurred regardless of whether the TOT state was resolved or unresolved. There also was a significant effect of resolution, F (1,39) = 4.451, $p < .05$. There were more TOT (Different-Unresolved) responses (M = 21.7%) than TOT (Different-Resolved) responses (M = 12.1%) and Table 17 shows that this effect occurred regardless of the level of lexical distinctiveness.

DON'T KNOW IT Responses. DON'T KNOW IT responses occurred on 14.7% of the valid trials. DON'T KNOW IT responses were separated into the three subtypes. The majority of DON'T KNOW IT responses were ones in which no word came to mind. The other two subtypes occurred on less than 2% of the valid trials and were excluded from further analyses.

A t-test was used to examine the effect of lexical distinctiveness on DON'T KNOW IT (No word) responses. Participants were just as likely to provide a DON'T KNOW IT (No word) response regardless of lexical distinctiveness (low lexical distinctiveness: M = 12.4%, (high lexical distinctiveness: M = 13.3%).

Duration Estimates. Table 18 displays the estimated duration since the target was last used as a function of lexical distinctiveness for the four different response types. The number of participants upon which the estimates were based also is also presented.

As in Experiments 3 and 4, statistical tests were not undertaken to make comparisons between response types or word frequency type because the composition of participants in each subsample differed across all means. Again though, the duration estimates are very similar to the estimates provided in Experiment 4 and in Experiment 3 for low frequency words. The estimated duration since a word was last used appeared to be smallest for KNOW IT (Same) responses, intermediate for TOT (Same-Unresolved) and TOT (Same-Resolved) states and largest for DON'T KNOW IT states. The only discrepancy is the relatively low estimate for TOT (Same-Resolved) responses when targets were low in lexical distinctiveness. This estimate, however, may not be very reliable as the number of participants that were used to calculate this estimate is relatively low. It should be pointed

Table 18

Estimated Duration (in months) Since Targets Were Last Used as a Function of Response Type and Lexical Distinctiveness

	Lexical Distinctiveness	
TOT Response Type	High	Low
KNOW IT (Same)	N = 38 5.10	N = 36 5.54
TOT (Same-Unresolved)	N = 27 10.03	N = 20 8.62
TOT RESOLVED (Same)	N = 23 9.69	N = 11 4.59
DON'T KNOW IT UNRESOLVED	N = 34 17.29	N = 33 10.96

out that the estimated durations associated with targets low in lexical distinctiveness appeared to be lower than the estimates associated targets high in lexical distinctiveness. There were, however, no statistical tests conducted to confirm this observation.

Discussion

There were two major findings in the present experiment regarding lexical distinctiveness and TOT states. First, there were fewer TOT (Same-Resolved) states when the target was low in lexical distinctiveness than when the target was high. One possible interpretation of this finding is that targets low in distinctiveness are harder to retrieve and also to resolve should a TOT state occur. The fact that there were fewer KNOW IT (same) states when words were low in distinctiveness than when words were high in distinctiveness is consistent with this interpretation.

It also is possible that targets high in lexical distinctiveness are easier to retrieve and thus easier to resolve if a TOT state occurs. Consistent with this interpretation, there were more KNOW IT (Same) states for targets that were high in lexical distinctiveness than for targets low in lexical distinctiveness. Without a suitable control condition however, it can not be shown conclusively whether the degree of lexical distinctiveness facilitates and/or inhibits the resolution and successful retrieval of targets.

The second major finding in the present experiment was that there were more TOT (Different) states when targets were low in lexical distinctiveness than when they were high in lexical distinctiveness. Normally, this finding would be difficult to interpret because the TOT states involved words that were different from the target intended by the experimenter so the effect cannot be reliably traced to the manipulation. However, in this particular case the manipulation of lexical distinctiveness can also be viewed as a manipulation of the number of potential targets for a particular definition. Viewed in this manner, then, the results suggest that a TOT state is more likely to occur when lexical distinctiveness is low or when there are more lexically related targets.

The second finding is partially consistent with the prediction generated by the inadvertent activation hypothesis. The more lexically related neighbours associated with a target, the greater likelihood of a neighbour becoming activated and once activated, these neighbours could block activation of the intended target and increase TOT probability. Moreover, although there was no direct evidence that TOT states were associated with lexically related 'blockers', there was some evidence that meaning related words were more likely to came to mind for targets that were low in lexical distinctiveness than for targets high in lexical distinctiveness. Across the four TOT subtypes, approximately 32% of the participants had at least one meaning related word come to mind when the target was low in lexical distinctiveness whereas only 18% had a meaning related word come to mind when the target was high in lexical distinctiveness. This also may reflect the fact that targets high in lexical distinctiveness have fewer synonyms available that can 'come to mind'.

The second finding, however, is not easily accounted for by the incomplete activation hypothesis as put forth Brown and McNeill (1966). One possibility is that targets low in lexical distinctiveness are not used as frequently because there are other synonyms available. The targets, however, were balanced for frequency. Similarly, it is not clear how Burke et al. would interpret this finding within Node Structure theory. Burke et al. (1991) suggested that TOT states were a result of weakened connections between lexical and phonological nodes. Presumably, targets that are low in lexical distinctiveness would have weaker connections to their respective phonological nodes for reasons that are unclear at present.

The duration estimates again provide mixed support for the Burke at al.'s (1991) model. The difference between estimates associated with KNOW IT (Same) states and TOT (Same) states are consistent with the model. The lack of difference between the estimates associated with TOT (Same-Unresolved) and TOT (Same-Resolved) however, are somewhat inconsistent their model.

General Discussion of Experiments 3, 4, and 5

In Experiments 3, 4, and 5, the goal was to test the predictions generated by the two competing views regarding TOT susceptibility for different types of targets. According to one version of the incomplete activation interpretation, TOT states are a result of reduced transmission of priming of phonological information brought about by weakened connections, connections that are affected by frequency of use (Burke et al., 1991). Thus, low frequency words and words that have not been used recently should be more susceptible to TOT states. In the fourth experiment, low frequency words were found to be just as susceptible to a TOT state as were a set of high frequency words carefully matched for initial letter, number of syllables and number of letters. It is possible that the frequency manipulation was not strong enough to detect the effect. This argument is weakened though, by the fact that KNOW IT states were sensitive to the frequency effect (i.e. high frequency words were easier to retrieve than low frequency words) as were the temporal duration estimates (high frequency words were associated with shorter durations than low frequency words).

The lack of a frequency effect is important because the inverse relation between word frequency and TOT states has been an implicit assumption of virtually all researchers interested in TOT states since Brown and McNeill first 'prospected' for TOT states in a laboratory setting. A. Brown (1991) also questions this assumption and points out that in diary studies (e.g. Cohen & Faulkner, 1986; Reason & Lucas, 1984), words involved in TOT states are often associated with a high level of familiarity. The lack of a frequency effect in the present study and the findings reported in diary studies suggests that the relation between word frequency and TOT probability should be examined more closely.

In addition to frequency, Burke et al. (1991) suggested that recency of activation also was related to TOT probability. The longer the duration since a word was last used, the greater the likelihood of a TOT. Accordingly, KNOW IT states should be associated with the shortest duration, unresolved TOT states with the longest duration, and resolved TOT states with a duration somewhere in between. The present findings offered mixed support for this prediction. Although estimates since last activation were longer for targets associated with a TOT state than targets associated with KNOW IT states, there were essentially no differences in the estimates associated with resolved TOT states from the estimates associated with unresolved TOT states. The same pattern of duration estimates occurred in Experiments 3, 4, and 5 suggesting the finding is reproducible.

Although the findings provide mixed support for the recency of activation, it should be noted the present set of experiments did not test for a causal relation between recency of activation and TOT probability. The estimates were always given after the response and they may be influenced by the type of response as much as or more than the actual passage of time. A more direct test of the recency hypothesis would entail some type manipulation involving the use of a word prior to the experimental task.

The second interpretation of the TOT phenomenon is based on the assumption that inadvertently activated words interfere with or inhibit activation of the target. This hypothesis was examined by looking at the TOT probability of words that differed in the number of phonologically related neighbours in Experiment 4 and in the number of lexically related neighbours in Experiment 5.

The results of Experiment 4 showed that phonological distinctiveness or the number of phonologically related neighbours associated with a target appeared to be directly related to TOT probability. Targets that were low in phonological distinctiveness had a higher TOT probability (although the difference was only marginally significant).

The results of Experiment 5 showed that the degree of lexical distinctiveness also affected TOT probability, depending on whether the TOT target was the word intended by the experimenter. When TOT targets were the same as the target intended by the experimenter, there were fewer TOT (Same-Resolved) responses when targets were low in lexical distinctiveness than when targets were high in lexical distinctiveness. Unfortunately, it is difficult to determine from the present set of results whether targets that are low in lexical distinctiveness are harder to resolve and retrieve, or targets that are high in lexical distinctiveness are easier to resolve and retrieve.

When the TOT targets were different from the targets intended by the experimenter, there were considerably more TOT responses for targets low in lexical distinctiveness than targets high in lexical distinctiveness. Although in this case, the TOT targets are different from the targets intended by the experimenter, they were often acceptable synonyms and thus interpretable as a 'legitimate' TOT. This finding suggests that the more lexical neighbours associated with a target, the greater likelihood of a

TOT state.

At first glance, this conclusion may seem somewhat counter-intuitive. Why would people be more likely to have a TOT experience when there are many potential targets available? On closer inspection, however, it may be that the availability of replacement words is the very reason that the intended target could not be activated in the first place. Moreover, it should be pointed out that these types of TOT experiences would probably not be very memorable; the availability of 'replacement' words would allow us to recover from these momentary lapses in word retrieval making the 'TOT' less than memorable.

This conclusion from Experiment 5 also may explain why older adults experience more TOT states than younger adults. The often reported age-related increase in vocabulary knowledge (e.g. Botwinick & Storandt, 1974) may cause a general decrease in the lexical distinctiveness of most targets. As a result, more lexically related neighbours would become inadvertently activated during word retrievals which would lead to a general increase in TOT states associated with aging.

Alternately, the lexical distinctiveness of targets may change with age independent of vocabulary knowledge. One possibility is that the number of semantic features associated with a given target decreases as age increases. As a result, targets decrease in lexical distinctiveness because there are fewer distinct features associated with a target. Consistent with this interpretation, several researchers have shown that older adults do not encode items as deeply as younger adults (e.g. Duchek, 1984; Simon, 1979) The shallow encoding may be a consequence of less distinctive meanings associated with targets.

In order to investigate these possibilities, the final experiment was conducted with young and older adults using the materials from Experiment 5. The goal of the final experiment was to assess the relations between lexical distinctiveness, age and TOT probability.

A final point that should be mentioned is that the general pattern of results found in Experiments 1 and 2 with regard to the amount and accuracy of information provided by participants in TOT states was also found in Experiments 3, 4, and 5. Participants were more accurate when in a TOT state than in a DON'T KNOW IT state, provided more information when the TOT state was unresolved, tended to be more accurate when a TOT state was resolved and were just as accurate when in a TOT state for a different word that was resolved. Across all five experiments, the pattern of means have been remarkably similar and suggest considerable stability in the data being reported.

Age and TOT Experiences

Age-related increases in TOT probability have been reported in diary studies (Burke et al., 1987; Cohen & Faulkner, 1986) and in experimental studies (Burke et al., 1991; Maylor, 1990a; although see Maylor, 1990b). In one diary study, participants were asked to record information about the frequency of TOT states and the nature of the information available in TOT states over a four week interval (Burke et al., 1987). Burke et al. (1987) found that the older adults reported over six TOT states a month compared to the less than four per month for younger adults. In a separate diary study Cohen and Faulkner (1986) asked participants to estimate the number of TOT states for proper names that occurred over a two week period and to provide a detailed report on the information available for one proper name TOT state. Cohen and Faulkner (1986) found that older adults estimated having four TOT states for proper names per week compared to the two per week for younger adults. Moreover, both diary studies reported that older adults had less information (i.e. beginning sounds, number of syllables, stress pattern, etc.) about the target they were trying to retrieve than did younger adults. Although there are problems with diary studies (i.e. selective reporting), the age difference was replicated and consistent with an age-related word finding deficit.

In the experimental studies, TOT states were induced by presenting definitions of rare words to participants and asking them to retrieve the word. Burke et al. (1991) used a variation of this procedure and presented definitions of five different types of low frequency words (non-object nouns, object nouns, adjectives and verbs, names of famous places, and names of famous people) to 42 participants from two different age groups. The participants indicated whether the word was known, not known, or on the tip of their tongue.

The primary finding reported by Burke et al. (1991) was an age-related increase in TOT states that appeared to be greatest for names of famous people. Burke et al. also found the opportunity for TOT states was not equivalent for both groups as older adults tended to recall and recognize more targets than did younger adults. When Burke et al. corrected for this age difference in item difficulty by expressing the frequency of TOT states over the number of unsuccessful retrievals (i.e. correct responses were excluded), they found older adults also experienced more TOT states for object nouns and adjectives and verbs than did younger adults.

Maylor (1990b) also examined the incidence of TOT states in older adults using the same materials and procedure developed by Jones and Langford (1987). Although the problems with this paradigm were noted earlier, Maylor found no evidence of an age-related increase in TOT probability for a group of participants ranging in age from 52 to 78 years. She did, however, report a significant negative correlation between the number of correctly reported features in TOT states and age, a finding that parallels the results of the cognitive diary studies by Burke et al. (1987) and Cohen and Faulkner (1986).

Maylor (1990a) also examined the age differences in the incidence of TOT states in response to naming famous faces. She presented a series of famous faces to participants between the ages of 50 and 80 and asked them to indicate whether they recognized the face and if they did, they were asked whether they knew the name. She found an age-related increase in the number of unresolved TOT states when participants were asked to provide a name as well as an age-related decrease in the number faces that were correctly named. Moreover, older adults were less likely to resolve a TOT to the right name and more likely to assign a wrong name to a face when they did recognize the face.

As discussed earlier, the reason for the age-related increase in TOT states remains elusive. Burke et al. (1991) attribute the increase in TOT to a generalized weakening of the connections that allow phonological information to be primed. The results of Experiment 5 in the present research suggest that the number of lexically related neighbours may be directly related to TOT probability. Furthermore, the age-related increase in TOT probability may arise because of the changes in vocabulary knowledge associated with age that drives down the lexical distinctiveness of words or because targets undergo an age-related change in lexical distinctiveness independent of vocabulary size. In order to examine these hypotheses further, the same set materials from Experiment 5 were used in experiment 6 on TOT states and aging. This enabled an investigation of the relationship between lexical distinctiveness, age and TOT probability.

Experiment 6

Method

Subjects. Sixty-seven community dwelling participants participated in the present study. The data from two older adults were excluded because they failed to follow the task instructions.

Of the remaining 65 participants, there were 30 adults, 16 males and 14 females, who ranged in age from 20 to 35 with a mean age of 26.70 in the younger age group and 35 participants, 18 males and 17 females, who ranged in age from 60 to 75 with a mean age of 71.65 in the older age group.

There were no age differences in the number of years of education (young adults: $\underline{M} = 13.63$, older adults: $\underline{M} = 13.73$). There were, however, reliable age differences on a test of vocabulary knowledge, $\underline{t}$ (62) = 5.32, $\underline{p} < .01$, (young adults: $\underline{M} = 9.62/18$, older adults: $\underline{M} = 13.74/18$). None of the participants had participated in any previous studies involving TOT experiences.

Materials. The materials from Experiment 5 were adapted into a take home task consisting of 2 parts plus a set of instructions. In part 1 of the take home task, the target definitions were presented. The identical materials from Experiment 5 were used in the present study. As in experiment 5, the 30 targets were divided into two lists (A and B) such that each list of words was balanced for number of syllables and each list contained an equal number of high and low lexically distinct targets. The order of targets in each list was randomly determined with the only exception that no more than 3 words of high or low lexical distinctiveness could occur in a row. Two presentation orders were created by presenting the two lists in both orders (A-B and B-A).

In part 1, each definition was printed on a single page, and below each definition, three possible responses were listed; KNOW IT, TOT, and DON'T KNOW IT. For TOT and DON'T KNOW IT responses, space was provided for participants to include information about the first letters, middle letters or end letters, the number of syllables and any related words that came to mind.

In part two of the take home task, the target definitions and the intended target were presented. Space also was provided for participants to indicate whether the target was familiar and if so, how long it had been since the target was used. Finally, in part two, there was a section for participants to indicate whether the target was the word they were seeking if they were in a TOT that was never resolved.

Parts one and two were sealed in separate envelopes. The instructions described the task requirements and specified when each envelope should be opened and completed.

Procedure. The instructions described the same procedure that was used in Experiments 3, 4 and 5 with the following modifications. First, instead of listening to the definitions, participants read the definitions at their own pace. Second, instead of presenting the intended target 45 seconds after the definition, all targets were presented after all definitions had been completed. Finally, instead of asking participants to list meaning related words and sound related words, participants were simply asked to list any 'related word' that came to mind.

After completing the task, participants brought all the materials with them for their next appointment in the memory project. The amount of time to complete the task ranged from 10 to 50 minutes with an average time of 30 minutes.

Results

The frequency of occurrence for the three basic response types was expressed as a percentage of valid trials. The average number of valid trials was 25.3 out of 30. Each response type was broken down further into subtypes and analyzed separately.

KNOW IT Responses. KNOW IT responses occurred on 80.9% of the valid trials. KNOW IT responses were separated into the two subtypes. KNOW IT (Same) responses were analyzed in a 2-way analysis of variance (ANOVA) with age as a between-subject variable and lexical distinctiveness as a within-subject variable. There was a significant effect of lexical distinctiveness, F (1, 63) = 47.308, $p < .001$. Participants were more likely to retrieve the intended word when it was high in lexical distinctiveness (M = 47.7%) than when it was low in distinctiveness (M = 36.0%). There was no difference in KNOW IT (Same) responses between young and older adults (young adults: M = 40.9%, old adults: M = 42.7%) but there was a significant interaction between age and lexical distinctiveness, F (1, 63) = 8.799, $p < .01$. The lexical distinctiveness effect was much smaller for older adults (high lexical distinctiveness: M = 46.2%, low lexical distinctiveness: M = 39.4%) than it was for younger adults (high lexical distinctiveness: M = 49.3%, low lexical distinctiveness: M = 32.1%).

KNOW IT (Different) responses were analyzed in an identical 2-way ANOVA. There was a significant effect of lexical distinctiveness, F (1, 63) = 11.777, $p < .01$. Participants were less likely to retrieve a different target when the intended target was high in lexical distinctiveness ($\underline{M}$ = 36.1%) than when it was low in distinctiveness ($\underline{M}$ = 41.9%). There were no age differences in the number of KNOW IT (Different) responses (young adults: $\underline{M}$ = 35.7%, old adults: $\underline{M}$ = 41.8%). The lexical distinctiveness effect appeared to be larger for younger adults (high lexical distinctiveness: $\underline{M}$ = 31.2%, low lexical distinctiveness: $\underline{M}$ = 40.6%) than it was for older adults (high lexical distinctiveness: $\underline{M}$ = 40.4%, low lexical distinctiveness: $\underline{M}$ = 43.0%), but the interaction between age and lexical distinctiveness only approached significance, $\underline{F}$ (1, 63) = 3.672, $\underline{p} < .07$.

TOT Responses. Tip-of-the-tongue responses occurred on 10.4% the valid trials. The TOT responses were separated into the four different subtypes. Table 19 lists the amount and accuracy of the information provided by all participants (collapsed across age groups) for the five different response types.

Overall, participants in Experiment 6 tended to provide less information than participants in the previous five experiments. Nevertheless, the pattern of means in Table 19 is generally consistent with pattern of means from the previous experiments and supports the conclusions drawn earlier regarding the difference between TOT responses and DON'T KNOW IT responses and the justification for including TOT (Different) responses.

An important finding from Table 19 concerns the remarkably high number of participants who provided one or more related words

Table 19

Accuracy of Information Provided by Participants in TOT States and DON'T KNOW IT States

	TOT Response Type				DON'T KNOW IT Response
	Same		Different		
	Unresolved	Resolved	Unresolved	Resolved	
	N = 16	N = 32	N = 21	N = 28	N = 33
BEGINNING SOUNDS					
% Correct	0.0	26.0		15.3	1.5
% Incorrect	3.1	1.0		4.2	10.8
% None Given	96.9	72.9	75.0	80.5	87.7
MIDDLE SOUNDS					
% Correct	0.0	7.8		1.8	0.0
% Incorrect	0.0	0.0		1.8	2.5
% None Given	100.0	92.2	90.5	96.4	97.5
END SOUNDS					
% Correct	0.0	12.0		12.5	0.0
% Incorrect	0.0	0.0		1.8	9.8
% None Given	100.0	88.0	85.7	85.7	90.2
NUMBER OF SYLLABLES					
% Correct	17.7	44.3		20.9	10.2
% Incorrect	24.0	12.0		15.4	31.6
% None Given	58.3	43.8	47.6	63.6	58.2
RELATED WORDS					
% Provided	71.7	18.8	59.5	24.4	1.5

while in a TOT state, especially if the TOT state was unresolved. An inspection of these words revealed that the clear majority were meaning related words as opposed to sound related words. This finding further serves to support the claim that the activation of meaning related words is a common occurrence for people in a TOT state.

Surprisingly, there were no age differences in the pattern of means shown in Table 19 except for the provision of related words. For TOT (Same-Unresolved), a smaller percentage of older adults provided related words ($\underline{M} = 55.8$) than did younger adults ($\underline{M} = 87.5$) although the difference only approached significance, $\underline{t}$ (14) = 1.667, $\underline{p} < .12$. For TOT (Different-Unresolved), a smaller percentage of older adults provided related words ($\underline{M} = 31.3$) than did younger adults ($\underline{M} = 76.9$) and the difference was significant, $\underline{t}$ (19) = 2.448, $\underline{p} < .05$. For TOT (Same-Resolved), a smaller percentage of older adults provided related words ($\underline{M} = 14.7$) than did younger adults ($\underline{M} = 23.3$) but the difference was not reliable. For the remaining response type, TOT (Different-Resolved), older adults were just as likely to provide a related word ($\underline{M} = 23.8$) as were younger adults ($\underline{M} = 25.0$).

Table 20 lists the percentage of valid trials for each of the four TOT subtypes as a function of age and lexical distinctiveness. The first two TOT subtypes in Table 20, TOT (Same-Unresolved) and TOT (Same-Resolved), were analyzed in 3-way ANOVA with resolution and lexical distinctiveness as within-subject variables and age as a between-subject variable.

Table 20

Percentage of TOT Response Types (out of all Retrieval Attempts) as a Function of Age and Lexical Distinctiveness

	Young Adults		Older Adults	
	Lexical Distinctiveness		Lexical Distinctiveness	
TOT Response Type	High	Low	High	Low
Same-Unresolved	2.5	1.7	1.6	1.9
Same-Resolved	2.0	4.6	2.4	2.9
Different-Unresolved	2.6	3.7	0.4	1.6
Different-Resolved	3.3	4.5	3.0	3.5

Table 21

Percentage of TOT Response Types (out of Unsuccessful Retrieval Attempts) as a Function of Age and Lexical Distinctiveness

	Young Adults		Older Adults	
	Lexical Distinctiveness		Lexical Distinctiveness	
TOT Response Type	High	Low	High	Low
Same-Unresolved	11.8	5.2	7.9	9.9
Same-Resolved	7.9	18.8	18.3	13.5
Different-Unresolved	12.7	15.7	1.0	9.6
Different-Resolved	9.3	15.3	25.0	22.4

There was no effect of lexical distinctiveness. Participants were just as likely to experience a TOT state regardless of whether the intended target was high or low in lexical distinctiveness (low lexical distinctiveness: M = 5.5%, high lexical distinctiveness: M = 4.3%). There also was no effect of age. Younger adults experienced just as many TOT states as did older adults (young adults: M = 5.4%, old adults: M = 4.4%). There was a marginally significant effect of resolution, F (1, 63) = 3.261, $p < .08$. There were more TOT states that were resolved (M = 3.0%) than TOT that were unresolved (M = 1.9%). None of the interactions were significant.

The other two TOT subtypes, TOT (Unresolved-Different) and TOT (Resolved-Different), were analyzed in an identical three-way ANOVA. There was a marginally significant effect of lexical distinctiveness, F (1, 63) = 3.908, $p < .06$. Participants were more likely to experience a TOT state involving a different word when the intended target was low in lexical distinctiveness (M = 6.5%), than when it was high in lexical distinctiveness (M = 4.5%). There also was a marginally significant effect of age, F (1, 63) = 3.148, $p < .09$. Surprisingly, younger adults experienced more TOT states (M = 7.0%) than did older adults (M = 4.3%). Finally, there was a marginally significant effect of resolution, F (1, 63) = 3.479, $p < .07$. There were more TOT (Different-Resolved) states (M = 3.5%) than TOT (Different-Unresolved) states (M = 2.0%). None of the interactions were significant.

The four TOT subtypes also were analyzed as percentages relative to unsuccessful retrievals. The means for the four TOT subtypes are shown in Table 21. Eighteen participants, 14 older adults and 4 young adults, were excluded from this analysis because they only provided KNOW IT responses.

The first two TOT subtypes in Table 21, TOT (Same-Resolved) and TOT (Same-Unresolved), were analyzed in a three-way ANOVA. None of the main effects were reliable but the effect of resolution was marginally significant, $\underline{F}$ (1, 45) = 3.442, $\underline{p}$ < .08. There were slightly more TOT (Same-Resolved) states ($\underline{M}$ = 15.6%) than TOT (Same-Unresolved) states ($\underline{M}$ = 8.7%). None of the interactions were significant.

The next two TOT subtypes in Table 21, TOT (Different-Resolved) and TOT (Different-Unresolved), also were analyzed in a three-way ANOVA. None of the main effects were significant although the effect of resolution approached significance, $\underline{F}$ (1, 45) = 3.215, $\underline{p}$ < .09. There were more TOT (Different-Resolved) states ($\underline{M}$ = 17.9%) than TOT (Different-Unresolved) states ($\underline{M}$ = 10.3%). There also was a significant interaction between age and resolution, $\underline{F}$ (1,45) = 4.893, $\underline{p}$ < .05. The resolution effect occurred for older adults (resolved: $\underline{M}$ = 23.9%,, unresolved $\underline{M}$ = 6.3%) but not for younger adults (resolved: $\underline{M}$ = 13.1%,, unresolved $\underline{M}$ = 13.6%).

DON'T KNOW IT Responses. DON'T KNOW IT responses occurred on 8.7% of the valid trials. The DON'T KNOW IT responses were separated into three different subtypes. The percentage of DON'T

KNOW IT (No word) responses was analyzed in a two-way ANOVA with lexical distinctiveness as a within-subject factor and age as a between-subject factor. There were no age differences in the number of DON'T KNOW IT (No word) responses (young adults: M = 5.1%, old adults: M = 5.4%) but the effect of lexical distinctiveness was significance, F (1,63) = 4.591, p < .05. Participants provided more DON'T KNOW IT (No word) responses when the intended target was low in lexical distinctiveness (M = 6.2%), than when it was high in lexical distinctiveness (M = 4.5%). There were no other significant effects.

The percentage of valid trials in which a word that came to mind was different from the word intended by the experimenter also was analyzed in a two-way ANOVA with lexical distinctiveness as a within-subject factor and age as a between-subject factor. There was a reliable effect of age, F (1, 63) = 16.699, p < .001. Younger adults had more DON'T KNOW IT (Different) responses (M = 5.4%) than did older adults (M = 1.4%). There were no other significant effects.

The percentage of valid trials in which a word that came to mind was the same as the word intended by the experimenter was extremely small for all participants (M = 0.2%) and excluded from any analysis.

Duration Estimates. Table 22 displays the estimated durations since the target was last used for the four different response types as a function of age and the number of participants upon which the estimates were based for each response type.

Table 22

Estimated Duration (in months) Since Targets Were Last Used as a Function of Response Type and Age

Response Type	Older Adults	Young Adults
KNOW IT (Same)	N = 34 11.12	N = 30 7.46
TOT (Same-Unresolved)	N = 6 19.73	N = 8 17.25
TOT (Same-Resolved)	N = 14 19.46	N = 14 15.46
DON'T KNOW IT UNRESOLVED	N = 15 29.66	N = 16 34.54

The pattern of duration estimates are generally consistent with the findings from the previous experiments. Duration estimates tend to be shortest for KNOW IT (Same) responses, longest for DON'T KNOW IT responses and intermediate for TOT responses. There were no systematic differences in the duration estimates as a function of distinctiveness but there was a tendency for older adults to give larger estimates than younger adults. The differences in duration estimates, however, only approached significance for KNOW IT responses, $\underline{t}$ (62) = 1.668, $\underline{p}$ < .11.

Discussion

There were several important findings in the present experiment. First, contrary to most of the previous studies on TOT states and aging, the present study found no age differences in TOT state probability. This finding was surprising and unexpected. It is possible that the lack of an age effect may be related to the reported age differences in vocabulary knowledge. The older adults in this study scored much higher on a vocabulary test than did the younger adults and may have found the TOT task 'easier'. Consistent with this, older adults' vocabulary scores were negatively related to the number of DON'T KNOW IT responses ($\underline{r}$ = -.385). However, when performance was examined relative to unsuccessful retrievals as a means of controlling for differences in item difficulty, there was still no differences between the two age groups.

The second major finding was that older adults were not as sensitive to the lexical distinctiveness of a target as were younger adults. Younger adults were more likely to retrieve the intended target when it was high in lexical distinctiveness and more likely to retrieve a different target when it was low in lexical distinctiveness. Older adults did not show this pattern and were as likely to retrieve the intended or an unintended target regardless of lexical distinctiveness. This finding suggests that there may be a tendency for lexical items to become lexically indistinct as age increases which may explain why TOT states increase with age. It should be pointed out, however, that the lexical distinctiveness norms were collected from university students.

Third, the older adults in the present study appeared to provide as much information as younger adults when in a TOT state, a finding that is again, contrary to previous reports on age and TOT states. The only exception was in the provision of related words where older adults tended to provide fewer related words than did younger adults for TOT (Same-Unresolved) and TOT (Different-Unresolved). This is a particularly interesting finding because in the earlier experiments in the present research, the number of meaning related words provided far exceeded the number of sound related words provided. It was suggested that the retrieval of meaning related may have been a consequence of a TOT state that aids in the eventual resolution. If this is correct, then the older adults in the present study may have found it 'harder' to resolve their TOT states. There was, however, an interaction between age and resolution. Older adults had just as many resolved TOT states as younger adults even though they had fewer unresolved states which is contrary to the above hypothesis.

Finally, older adults tended to give longer duration estimates than younger adults for KNOW IT Responses and TOT (Same-Unresolved) although the differences were not statistically reliable. This observation is consistent with Burke et al.'s (1991) interpretation of the previously reported age-related increase in TOT states. There was, however, no age-related increase in TOT states in the present study.

General Discussion and Conclusions

There are two major conclusions that can be drawn from the present study. First, TOT states may have little to do with the 'status' of the connections between lexical and phonological nodes and more to do with the number of such connections.
Tip-of-the-tongue probability appears to increase as the number of phonologically related and lexically related neighbours increase.

These findings are somewhat consistent with the inadvertent activation hypothesis. The more neighbours associated with a target, the greater the likelihood of one of the neighbours becoming activated and interfering with or blocking access to the target. There was, however, no direct evidence that 'blockers' were associated with TOT states in the present set of studies.

These findings, however, also can be interpreted within Node Structure theory. Assuming that priming in Node Structure theory is limited, phonologically related targets can be viewed as 'competing' for the limited priming at the lexical level. When there are many phonologically related targets in competition, there will be less priming overall and hence a greater likelihood that the phonological information associated with any given target will be less accessible.

Moreover, one can further assume that priming at the lexical level also is limited and that lexically related targets will compete for the limited semantic priming. When there are many lexically related targets in competition, there will be less priming overall at the lexical level and hence a greater likelihood that any given lexical item will be less accessible along with its corresponding phonological information.

Thus, Node Structure theory can, in principle, account for most, if not all, of the predictions generated by the inadvertent activation hypothesis. More importantly, Node Structure theory provides a principled explanation for why 'blockers' become activated in the first place. As the number of related nodes increases, the probability of any node becoming completely primed and ready for activation decreases.

It is unclear, however, why word frequency had no effect on TOT probability. The lack of an effect is problematic for Node Structure theory as well as the inadvertent activation hypothesis but further research is necessary before the null hypothesis can be accepted.

The second major conclusion is that older adults may have more trouble retrieving words because there is an age-related loss in lexical distinctiveness. Although older adults did not experience more TOT states than younger adults as might be expected on the basis of previous research, there were interactions between age and lexical distinctiveness in the number of KNOW IT (Same) and KNOW IT (Different) responses. The nature of these interactions suggested that older adults were not sensitive to the distinctiveness manipulation. For older adults, the difference between targets that differed in lexical distinctiveness was negligible for both types of KNOW IT responses. The lack of sensitivity to lexical distinctiveness on the part of older adults along with the effect of lexical distinctiveness on TOT probability in younger adults seems to implicate lexical distinctiveness as a major factor in the age-related problems in word retrieval.

It was suggested earlier that an age-related decrease in the lexical distinctiveness of words could be brought about by increases in vocabulary knowledge. There was, however, no correlation between vocabulary score and TOT probability in the older group. It was also suggested that an age-related decrease in lexical distinctiveness could occur independently of vocabulary knowledge. Older adults may not encode items as distinctively as younger adults and as a result, priming would be 'spread out' among more lexically related neighbours which would further increase the likelihood of a TOT experience. To examine this possibility, further research could be directed toward an examination of possible age differences in encoding words that differ in lexical distinctiveness.

Although the word finding problems of older adults are still not completely understood, the results of the present research have advanced an important hypothesis regarding lexical distinctiveness and age. According to this hypothesis, older adults use more indefinite references in expressive language (e.g. Heller, Dobbs, & Rule, submitted) because there are more closely related words 'competing' for activation which lowers the probability of accessing the correct item. Similarly, older adults may make more errors when naming pictures because closely related words compete for activation. Indeed, the majority of errors made by older adults are related to the picture in question (Albert et al., 1988). Thus, this hypothesis may prove to be extremely helpful for understanding the word finding problems associated with aging.

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Appendix 1
Summary of Data from Normative Study

The data presented below is a summary of the findings from the normative study. There were 123 participants in the first session and 59 participants in the second session. The first column lists the target and the next 4 columns provide the following normative information about the target:

U - number of participants who indicated that the target was unfamiliar
NS - number of participants who did not provide a synonym even though familiar with target
NF - number of participants who did not provide familiarity information
%NS - percentage of participants who did not provide a synonym even though familiar with target

The sixth column lists the synonyms that were most often provided. The last two columns provide the following normative information about each synonym:

# - number of participants who provided the synonym
% - percentage of participants (out of all participants familiar with target) who provided the synonym

TARGET	U	NS	?	%NS	SYNONYMS	#	%
parachute	0	81	0	65.3	sky dive	5	4.0
					balloon	4	3.2
					chute	3	2.4
moustache	0	53	0	42.7	facial hair	26	20.9
					beard	19	15.3
					hair	17	13.7
zealot*	34	9	2	39.1	fanatic	9	39.1
					radical	2	8.6
					extremist	1	4.3
morgue	0	46	0	37.0	funeral home	22	17.7
					mortuary	14	11.2
					cemetery	12	9.6
harem	6	43	0	36.4	wives	21	17.7
					group	13	11.0
					concubines	6	5.0
mermaid	0	43	0	34.6	fish woman	17	13.7
					fish	13	10.4
					1/2fish 1/2w	10	8.0

TARGET	U	NS	?	%NS	SYNONYMS	#	%
pyramid	0	42	0	33.8	triangle	25	20.1
					tomb	11	8.8
					temple	8	6.4
nemesis*	17	13	2	32.5	enemy	16	40.0
					rival	7	17.5
					foe	6	15.0
heretic	33	29	0	31.8	non-believer	8	8.7
					blasphemer	7	7.6
					disbeliever	5	5.4
matriarch	54	20	2	29.4	mother	19	27.9
					queen	7	10.2
					female dominanc	4	5.8
comet	0	34	0	27.4	meteor	22	17.7
					star	19	15.3
					shooting star	19	15.3
monastery	2	30	0	24.5	church	43	35.2
					convent	19	15.5
					nunnery	12	9.8
dowry	16	26	0	24.0	payment	30	27.7
					gift	13	12.0
					money	9	8.3
nebula	49	17	1	22.9	stars	14	18.9
					cluster	7	9.4
					galaxy	6	8.1
valet*	3	12	1	21.8	attendant	13	23.6
					servant	11	20.0
					butler	10	18.1
zombie	0	27	0	21.7	monster	23	18.5
					living dead	22	17.7
					undead	17	13.7
kiosk*	29	6	1	20.6	booth	14	48.2
					stand	6	20.6
					shop	4	13.7
minstrel	31	19	0	20.4	musician	49	52.6
					singer	16	17.2
					entertainer	12	12.9

TARGET	U	NS	?	%NS	SYNONYMS	#	%
tycoon	6	24	0	20.3	businessman	34	28.8
					millionaire	24	20.3
					rich	15	12.7
lava	0	25	0	20.1	molten rock	44	35.4
					magma	17	13.7
					rock	11	8.8
neuron	0	22	0	17.7	nerve	34	27.4
					nerve cell	28	22.5
					cells	12	9.6
syringe*	0	9	0	15.2	needle	49	83.0
					injection	4	6.7
					hypodermic	4	6.7
deity	42	12	1	14.8	god	56	69.1
					spirit	9	11.1
					goddess	6	7.4
hibachi*	17	6	0	14.2	barbecue	32	76.1
					grill	10	23.8
					stove	8	19.0
fallacy	8	16	0	13.7	lie	42	36.2
					untruth	33	28.4
					false	26	22.4
cabaret	13	15	1	13.6	party	39	35.4
					dance	18	16.3
					bar	18	16.3
bauble	49	10	1	13.5	trinket	20	27.0
					toy	7	9.4
					jewelry	5	6.7
bough	14	13	2	12.0	branch	74	68.5
					limb	33	30.5
					twig	12	11.1
hovel	52	8	2	11.4	shack	19	27.1
					home	14	20.0
					house	13	18.5
parable*	15	5	0	11.3	story	29	65.9
					fable	13	29.5
					tale	12	27.2

TARGET	U	NS	?	%NS	SYNONYMS	#	%
podium	0	14	0	11.2	stand	75	60.4
					stage	18	14.5
					lectern	12	9.6
cask	38	9	6	11.2	barrel	29	36.2
					container	25	31.2
					keg	17	21.2
tentacle	3	12	0	9.9	appendage	48	39.6
					limb	22	18.1
					arm	12	9.9
mentor	11	11	0	9.7	teacher	41	36.2
					idol	29	25.6
					hero	15	13.2
robot	0	12	0	9.6	machine	78	62.9
					computer	23	18.5
					android	21	16.9
labyrinth	20	10	0	9.6	maze	87	83.6
					puzzle	28	26.9
					catacomb	3	2.8
limerick	4	10	0	8.3	poem	77	64.1
					rhyme	64	53.3
					joke	11	9.1
foal	36	6	0	6.8	horse	27	30.6
					colt	27	30.6
					baby horse	24	27.2
sabre	17	7	2	6.6	sword	89	84.7
					knife	25	23.8
					daggers	12	11.4
vaccine	0	7	0	5.6	medicine	33	26.6
					cure	33	26.6
					immunization	16	12.9
typhoon	5	6	1	5.0	storm	67	56.7
					hurricane	53	44.9
					wind	14	11.8
cavern	2	6	0	4.9	cave	105	86.0
					tunnel	26	21.3
					hole	14	11.4

TARGET	U	NS	?	%NS	SYNONYMS	#	%
felony	1	6	0	4.8	crime	106	86.1
					offence	16	13.0
					wrong doing	16	13.0
caviar	0	6	0	4.8	fish eggs	96	77.4
					delicacy	25	20.1
					eggs	15	12.0
cadaver	17	4	1	3.7	corpse	58	54.7
					dead body	27	25.4
					stiff	22	20.7
murmur*	0	2	0	3.3	whisper	39	66.1
					mumble	25	42.3
					mutter	6	10.1
tornado	0	4	0	3.2	storm	48	38.7
					twister	26	20.9
					whirlwind	23	18.5
morsel*	1	1	0	1.7	piece	31	53.4
					tidbit	14	24.1
					bit	14	24.1
marsh*	0	1	0	1.6	swamp	51	86.4
					slough	22	37.2
					pond	18	30.5
venom*	0	0	0	0.0	poison	56	94.9
					serum	5	8.4
					toxin	4	6.7
burglar	0	0	0	0.0	thief	102	82.2
					robber	83	66.9
					criminal	47	37.9
mannequin	0	0	0	0.0	dummy	71	57.2
					doll	44	35.4
					model	39	31.4
REJECTED TARGETS							
broach	0	7	0	5.6	pin	94	75.8
					jewelry	56	45.1
					pendant	11	8.8
clique	19	12	0	11.4	group	74	70.4
					gang	13	12.3
					crowd	7	6.6

TARGET	U	NS	?	%NS	SYNONYMS	#	%
protege	23	21	0	20.7	student	12	11.8
					apprentice	12	11.8
					understudy	10	9.9
stigma	20	43	1	41.7	label	6	5.8
					reputation	3	2.9
					stereotype	3	2.9
thesaurus	0	24	0	19.3	dictionary	51	41.1
					book	20	16.1
					synonyms	16	12.9
alimony	0	18	0	14.5	payment	56	45.1
					money	19	15.3
					support	13	10.4
anvil	15	49	0	44.9	hammer	19	17.4
					weight	7	6.4
					tool	6	5.5
aviary	55	18	2	26.8	birdhouse	13	19.4
					bird cage	12	17.9
					bird sanctuary	8	11.9
echelon	67	12	1	21.4	level	18	32.1
					hierarchy	6	10.7
					class	6	10.7
embryo	0	15	0	12.0	fetus	70	56.4
					egg	21	16.9
					baby	21	16.9
ghoul	2	6	0	4.9	ghost	81	66.3
					goblin	52	42.6
					monster	44	36.0
pseudonym	55	19	4	29.2	alias	23	35.3
					synonym	7	10.7
					pen name	6	9.2

Note:
* - targets presented in the second session

Appendix 2
Stimulus Materials for Experiments 1 and 2

The following targets are presented in the order they appeared in Experiments 1 and 2. The definition for each target also is presented along with the four non-targets associated with each target. For catch trials, the same semantically unrelated non-target and phonologically unrelated non-target was presented in all conditions in both experiments.

List A

BURGLAR
A person who forcibly gains entry into a building with intent to steal

Semantically related non-target - thief
Semantically unrelated non-target - niece
Phonologically related non-target - ballad
Phonologically unrelated non-target - pillow

MINSTREL
A medieval musician and entertainer

Semantically related non-target - bard
Semantically unrelated non-target - sash
Phonologically related non-target - magnet
Phonologically unrelated non-target - rodent

VENOM - Catch trial
A poisonous substance usually secreted by an animal

Non-target - damsel

CASK
A barrel-shaped container used for holding liquids

Semantically related non-target - keg
Semantically unrelated non-target - gym
Phonologically related non-target - curd
Phonologically unrelated non-target - gill

NEBULA
An immense body of thinly spread gas or dust in outerspace

Semantically related non-target - star
Semantically unrelated non-target - disk
Phonologically related non-target - narrative
Phonologically unrelated non-target - submarine

LIMERICK
A light or humorous verse of 5 lines

Semantically related non-target - poem
Semantically unrelated non-target - suit
Phonologically related non-target - location
Phonologically unrelated non-target - restaurant

TYCOON
A business man of exceptional wealth and power

Semantically related non-target - entrepreneur
Semantically unrelated non-target - metropolis
Phonologically related non-target - tenant
Phonologically unrelated non-target - puppet

PODIUM
A raised stand in a large room used especially for conducting

Semantically related non-target - lectern
Semantically unrelated non-target - neutron
Phonologically related non-target - pagoda
Phonologically unrelated non-target - violin

MATRIARCH
A mother who is the head and ruler of her family and descendents

Semantically related non-target - queen
Semantically unrelated non-target - bread
Phonologically related non-target - magazine
Phonologically unrelated non-target - hydrogen

KIOSK - Catch trial
A small light structure with one or more open sides used especially as a news stand

Non-target - bushel

HOVEL
A small, wretched, and often dirty house or home

Semantically related non-target - shack
Semantically unrelated non-target - veal
Phonologically related non-target - helmet
Phonologically unrelated non-target - coupon

CABARET
A restaurant serving liquor and providing entertainment

Semantically related non-target - nightclub
Semantically unrelated non-target - rainstorm
Phonologically related non-target - commando
Phonologically unrelated non-target - volcano

FELONY
An offence for which the punishment is imprisonment for more than one year

Semantically related non-target - crime
Semantically unrelated non-target - tongue
Phonologically related non-target - funeral
Phonologically unrelated non-target - museum

ZOMBIE
A corpse said to be revived by witchcraft

Semantically related non-target - monster
Semantically unrelated non-target - banquet
Phonologically related non-target - zenith
Phonologically unrelated non-target - wallet

TENTACLE
A long flexible projection about the head or mouth

Semantically related non-target - appendage
Semantically unrelated non-target - confidant
Phonologically related non-target - torpedo
Phonologically unrelated non-target - parasite

SABRE
A cavalry sword with a curved blade, thick back and guard

Semantically related non-target - knife
Semantically unrelated non-target - boat
Phonologically related non-target - senate
Phonologically unrelated non-target - title

List B
HERETIC
One who dissents from an accepted belief or doctrine

Semantically related non-target - blasphemer
Semantically unrelated non-target - catalyst
Phonologically related non-target - hexagon
Phonologically unrelated non-target - decimal

COMET
A small bright celestial body that often develops a cloudy tail when in orbit around the sun

Semantically related non-target - meteor
Semantically unrelated non-target - subsidy
Phonologically related non-target - canal
Phonologically unrelated non-target - napkin

MENTOR
A trusted counsellor or guide

Semantically related non-target - teacher
Semantically unrelated non-target - bottle
Phonologically related non-target - message
Phonologically unrelated non-target - coffee

TYPHOON
A tropical storm that often occurs in eastern Asia.

Semantically related non-target - hurricane
Semantically unrelated non-target - microscope
Phonologically related non-target - terrain
Phonologically unrelated non-target - mansion

NEURON - Catch trial
The fundamental functional unit of the nervous system

lunatic

FALLACY
An often plausible statement based on false or invalid information

Semantically related non-target - lie
Semantically unrelated non-target - leg
Phonologically related non-target - formula
Phonologically unrelated non-target - minister

VACCINE
A substance that is administered to produce or artificially increase immunity to a particular disease

Semantically related non-target - medicine
Semantically unrelated non-target - festival
Phonologically related non-target - victim
Phonologically unrelated non-target - sewage

LABYRINTH
A place that is full of intricate passageways and blind alleys

Semantically related non-target - maze
Semantically unrelated non-target - ramp
Phonologically related non-target - lullaby
Phonologically unrelated non-target - kerosine

CAVIAR
Processed salted fish eggs that come from a large fish such as the sturgeon

Semantically related non-target - delicacy
Semantically unrelated non-target - supervisor
Phonologically related non-target - constable
Phonologically unrelated non-target - metaphor

DOWRY
The money, goods, or estate that a woman brings to her husband in marriage

Semantically related non-target - payment
Semantically unrelated non-target - career
Phonologically related non-target - dollar
Phonologically unrelated non-target - wagon

MANNEQUIN
A form representing the human figure often used for displaying clothes.

Semantically related non-target - dummy
Semantically unrelated non-target - pigeon
Phonologically related non-target - metronome
Phonologically unrelated non-target - synagogue

FOAL
The young of an animal of the horse family

Semantically related non-target - colt
Semantically unrelated non-target - wing
Phonologically related non-target - fame or fork
Phonologically unrelated non-target - bunk

PYRAMID
A massive structure often found in Egypt with a square base and four triangular faces meeting at a point

Semantically related non-target - tomb
Semantically unrelated non-target - wart
Phonologically related non-target - paradise
Phonologically unrelated non-target - mercury

VALET - Catch trial
A man's male servant who performs personal services

fiesta

LAVA
Fluid rock that comes from a volcano

Semantically related non-target - magma
Semantically unrelated non-target - mural
Phonologically related non-target - lily

Phonologically unrelated non-target - silo

ROBOT

A machine that looks like a human being and performs various complex activities

Semantically related non-target - android
Semantically unrelated non-target - dolphin
Phonologically related non-target - ravine
Phonologically unrelated non-target - salon

Appendix 3
Stimulus Materials for Experiment 3

The following targets were used in Experiment 3 and are presented in the order in which they appeared. The number in brackets refers to the frequency of occurrence according to Francis and Kucera (1967).

List A
MAGAZINE (39)
Periodical publication containing contributions by various writers

COMET (2)
A small bright celestial body that often develops a cloudy tail when in orbit around the sun

HOVEL (2)
A small, wretched, and often dirty house or home

FUNERAL (33)
The ceremonies held for a dead person before burial

CAVIAR (1)
Processed salted fish eggs from a large fish such as the sturgeon

ROBOT (1)
A machine that looks like a human being and performs various complex activities

MISSILE (48)
A self propelled unmanned weapon

SADDLE (25)
A padded leather covered seat used on horses

COLONY (28)
A body of people sent out by the state to a inhabit a new territory

MONASTERY (2)
A house for persons under religious vows

DEVIL (25)
The supreme spirit of evil

CAVALRY (26)
Soldiers on horseback or in motor vehicles

MANNEQUIN (1)
A form representing the human figure often used for displaying clothes.

BURGLAR (1)
A person who forcibly gains entry into a building with intent to steal

CAMPUS (33)
The grounds and buildings of a college or school

List B
DOWRY (2)
The money, goods, or estate that a woman brings to her husband in marriage

CADAVER (1)
A dead body intended for dissection

MINSTREL (2)
A medieval musician and entertainer

RADAR (23)
A detecting device that establishes the distance, height, and direction of motion of an object

FALLACY (1)
An often plausible statement based on false or invalid information

CAMERA (36)
A device that can record the image of an object on a light sensitive surface

MEDICINE (30)
A substance or preparation used in treating disease

CABARET (1)
A restaurant serving liquor and providing entertainment

HARBOR (37)
A place of shelter for ships

MISSIONARY (17)
A person commissioned by the church to propagate its faith in new territories

CANVAS (19)
A strong cloth used especially for making tents and sails

SABRE (2)
A sword with a curved blade, thick back and guard

MATRIARCH (1)
A mother who is the head and ruler of her family and descendents

CAVERN (1)
An underground chamber of large or indefinite extent

BALLET (45)
A dance in which fixed poses and steps are combined with light flowing movements to convey a story

Appendix 4
Stimulus Materials for Experiment 4

The following targets were used in Experiments 4 and are presented in the order they appeared. The letter in brackets refers to the level of phonological distinctiveness (H = high and L = Low) according to the normative data in Appendix 1.

List A

CABARET (H)
A restaurant serving liquor and providing entertainment

MONASTERY (H)
A house for persons under religious vows

TYCOON (L)
A business man of exceptional wealth and power

CAVERN (H)
An underground chamber of large or indefinite extent

MERMAID (L)
A legendary sea creature with a woman's body and a fish's tail

PARACHUTE (L)
A large umbrella shaped device used for making a descent from an airplane

HAREM (H)
A group of women associated with one man

MINSTREL (L)
A medieval musician and entertainer

FOAL (H)
The young of an animal of the horse family

CAVIAR (H)
Processed salted fish eggs from a large fish such as the sturgeon

NEURON (L)
The fundamental functional unit of the nervous system

DEITY (L)
A being who is exalted as supremely good or powerful

MORGUE (H)
A place where the bodies of persons found dead are kept until released for burial

ROBOT (L)

A machine that looks like a human being and performs various complex activities

LIMERICK (H)
A light or humorous verse of 5 lines

List B
HOVEL (H)
A small, wretched, and often dirty house or home

MATRIARCH (H)
A mother who is the head and ruler of her family and descendents

DOWRY (L)
The money, goods, or estate that a woman brings to her husband in marriage

HERETIC (H)
One who dissents from an accepted belief or doctrine

PODIUM (L)
A raised stand in a large room especially for a orchestral conductor

MENTOR (L)
A trusted counsellor or guide

CASK (H)
A barrel-shaped container used for holding liquids

TYPHOON (L)
A tropical storm that often occurs in eastern Asia

MUSTACHE (H)
The hair growing on the human upper lip

SABRE (H)
A calvary sword with a curved blade, thick back and guard

VACCINE (L)
A substance that is administered to produce or artificially increase immunity to a particular disease

NEBULA (L)
An immense body of thinly spread gas or dust in outerspace

COMET (H)
A small bright celestial body that often develops a cloudy tail when in orbit around the sun

TENTACLE (L)

A long flexible projection about the head or mouth

PYRAMID (L)
A massive structure with a square base and four triangular faces meeting at a point

Appendix 5
Stimulus Materials for Experiments 5 and 6

The following targets were used in Experiments 5 and 6 and are presented in the order they appeared. The letter in brackets refers to the level of lexical distinctiveness (H = high and L = Low) according to the normative data in appendix 1.

List A

COMET (H)
A small bright celestial body that often develops a cloudy tail when in orbit around the sun

MINSTREL (H)
A medieval musical entertainer

TYPHOON (L)
A tropical storm that often occurs in eastern Asia

HOVEL (L)
A small, wretched, and often dirty house or home

MORGUE (H)
A place where the bodies of persons found dead are kept until released for burial

DEITY (L)
One exalted or revered as supremely good or powerful

CABARET (L)
A restaurant serving liquor and providing entertainment

NEBULA (H)
An immense body of thinly spread gas or dust in interstellar space

MANNEQUIN (L)
A form representing the human figure often used for displaying clothes.

HERETIC (H)
One who dissents from an accepted belief or doctrine

MERMAID (H)
A legendary sea creature with a woman's body and a fish's tail

PYRAMID (H)
A massive structure often found in Egypt with a square base and four triangular faces meeting at a point

ZEALOT (L)
A person who is uncompromising and extremely enthusiastic

MUSTACHE (H)
The hair growing on the human upper lip

SYRINGE (L)
A device used for injecting or withdrawing liquids from the body

List B
HAREM (H)
A group of women associated with one man

MENTOR (L)
A trusted counsellor or guide

CAVERN (L)
An underground chamber of large or indefinite extent

SABRE (H)
A sword with a curved blade, thick back and guard

MATRIARCH (H)
A mother who is the head and ruler of her family and descendents

ZOMBIE (H)
A corpse said to be revived through witchcraft

HIBACHI (L)
A pan used for burning charcoal and cooking food

MURMUR (L)
A low indistinct and often continuous sound

TYCOON (H)
A business man of exceptional wealth and power

PARABLE (L)
A simple story told to illustrate a moral truth

CAVIAR (H)
Processed salted fish eggs from a large fish such as the sturgeon

MORSEL (L)
A small piece or quantity

DOWRY (H)
The money, goods, or estate that a woman brings to her husband in marriage

MARSH (L)
A tract of soft wet land

NEMESIS (L)
A formidable and usually victorious rival